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(54) Personal computer for performing charge and switching control of different types of battery packs.

(57) A personal computer of this invention has a battery pack mounting section (31R) for detachably receiving battery packs having different current capacities. The personal computer also includes a switch mechanism (70, 304) for detecting whether a battery pack has a high or low capacity. Battery characteristic values consisting of charge and discharge voltage/current characteristics in units of batteries are prestored in a memory in a power control CPU (PC-CPU) (306). The PC-CPU (306) refers to the memory on the basis of capacity data from the switch mechanism and reads out the corresponding battery characteristic data. A power supply circuit (30) performs optimal charge control on the basis of this characteristic data. Two battery packs are prepared. When the PC-CPU (306) detects that the currently used battery pack is in a low-battery state, it selects the other battery pack to supply the operating power to the personal computer. At the same time the PC-CPU (306) performs optimal charge control of the battery in the low-battery state.

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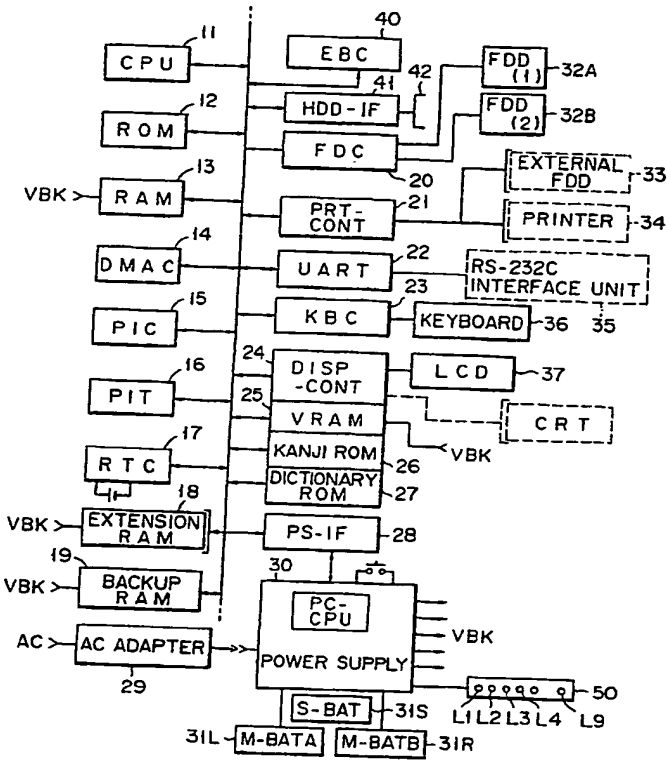
CPU
11
ROM
12
RAM
13
VBK
DMAC
14
PIC
15
PIT
16
RTC
17
EXTENSION RAM
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VBK
BACKUP RAM
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VBK
AC
AC ADAPTER
29
40
EBC
41
42
HDD-IF
FDC
20
PRT-CONT
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UART
22
23
KBC
24
DISP-CONT
25
VRAM
KANJI ROM
26
DICTIONARY ROM
27
PS-IF
28
30
PC-CPU
POWER SUPPLY
VBK
S-BAT
31S
31L
M-BATA
M-BATB
31R
FDD (1)
32A
FDD (2)
32B
EXTERNAL FDD
33
PRINTER
34
RS-232C INTERFACE UNIT
KEYBOARD
36
35
LCD
37
CRT
VBK
50
L1 L2 L3 L4 L9

FIG. 1

PERSONAL COMPUTER FOR PERFORMING CHARGE AND SWITCHING CONTROL OF DIFFERENT TYPES OF BATTERY PACKS

The present invention relates to a personal computer for performing charge control of batteries having different capacities and switching control of a plurality of battery packs.

In recent years, various types of portable, battery-driven personal computers have been developed. When such a personal computer is used with an AC adapter or a built-in battery, an operating power supply state must always be monitored, and all failures caused by abnormal power supply states must be eliminated.

A battery pack having a plurality of units each consisting of a primary battery (dry battery) and a secondary battery (rechargeable battery) is employed as a power supply for driving a lap-top computer or the like. When a battery is used as a power supply, in order to assure an operation of electronic equipment, the power level of the battery must be detected to perform battery replacement control and battery charge control for charging timings of the battery. A terminal voltage, a charge current, or discharge current of the battery is detected, the detected value is compared with a rated value of the battery, and battery charge control is performed on the basis of the comparison result. These control operations, however, realized by a circuit entirely constituted by hardware.

Since charge control is performed by only hardware, batteries used must be limited to a specific type of battery. The rated value of the battery must be a fixed value based on the battery characteristics. When batteries having different charge and discharge characteristics are used, charge control, remaining battery capacity computation, and low-battery detection cannot be accurately performed. Charge control corresponding to types of batteries cannot be performed. For example, a nickel-hydrogen battery compatible with a nickel-cadmium battery and having a larger capacity than the nickel-cadmium battery is to be used in electronic equipment having a characteristic value of the nickel-cadmium battery, charging and discharging of the nickel-hydrogen battery are controlled on the basis of the characteristic value of the nickel-cadmium battery, the performance of the nickel-hydrogen battery cannot be sufficiently maximized.

A relatively inexpensive low-capacity battery and a relatively expensive high-capacity battery cannot be selectively used. When charge control is performed in accordance with the types of battery, a circuit arrangement constituted by only hardware is undesirably complicated.

A power supply controller monitors a voltage of a battery used to supply power. When the monitored battery voltage is lowered to a voltage which does not allow supply of a power enough to operate a computer, this battery is determined to have a low-battery state. When the battery voltage reaches a predetermined voltage slightly higher than a voltage corresponding to the low-battery state, an alarm is generated to signal a low battery voltage level to a user.

When a battery in the low-battery state is slightly charged, a conventional power supply controller determines that the slightly charged battery is not set in a low-battery state, thereby performing power supply control of the battery.

When the battery in the low-battery state is, however, used upon slight charging, the battery voltage is abruptly lowered, and the battery is set soon in the low-battery state. Therefore, the computer power supply is cut off without generating the alarm. In a computer having a resume function, the computer is powered off before resume processing is completed. Therefore, the resume function cannot be sufficiently utilized.

It is an object of the present invention to provide a portable personal computer wherein when two types of battery packs, i.e., high- and low-capacity battery packs, are to be used, charge control, remaining battery capacity computation, and low-battery detection can be performed in accordance with the different types of battery packs, and when two battery packs can be mounted and are used for a long period of time, automatic switching of the battery packs, and their charge control can be performed to always maintain a stable battery power supply state and ensure highly reliable battery-driven processing operations.

According to the first aspect of the present invention, a personal computer comprises: data storage means; data processing means; a battery pack storage section for storing any of battery packs having different current capacities; means for detecting a current capacity of a battery pack stored in the battery pack storage section; means for charging the stored battery pack on the basis of the current capacity detected by the detecting means; and means for generating an operating power from the battery pack stored in the battery pack storage means.

According to the second aspect of the present invention, a personal computer comprises: data storage means; data processing means; at least two battery pack storage sections for respectively storing at least two battery packs; means for detecting each of current capacities of the battery packs stored in the plurality of battery pack storage

sections; means for performing charge control of the battery packs on the basis of the current capacities detected by the detecting means; means for selecting one of the plurality of battery packs; and means for generating an operating power from the selected battery pack.

According to the third aspect of the present invention, a charge control system comprises: a battery mounting section capable of receiving different types of batteries; means for determining types of batteries mounted in the mounting section; storage means for prestoring characteristic values of the different types of batteries; and charge control means for reading out the battery characteristic values from the storage means on the basis of the batteries determined by the determining means and for performing battery charge control on the basis of the readout characteristic values.

According to the present invention, a battery pack mounted in a battery pack mounting section can be charged at high speed in optimal conditions. Therefore, the battery power supply state is always kept stable, and highly reliable battery-driven processing operations can be ensured.

When a pair of battery packs is used as first and second main batteries in units of packs, the battery pack serving as the main battery can be controlled at high speed in optimal conditions. The battery power supply state is always kept stable, and highly reliable battery-driven processing operations can be ensured.

Charge control of batteries having different characteristics is performed in accordance with types of batteries, the capabilities of the batteries can be sufficiently enhanced. Therefore, the batteries having different current capacities can be fully charged within the same charge time.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram showing an embodiment of a personal computer according to the present invention;

Fig. 2 is a block diagram showing an arrangement of a power supply circuit shown in Fig. 1;

Fig. 3 is a flow chart of a charge control routine executed by a power control CPU 306 shown in Fig. 2;

Figs. 4A through 4C are flow charts of a battery-driven power-on routine executed by the power control CPU 306 shown in Fig. 2;

Figs. 5A and 5B are views for explaining display contents of a state display unit in accordance with charge control shown in Fig. 3;

Figs. 6A through 6C are views for explaining display contents of the state display unit in accordance with battery-driven control shown in Figs. 4A through 4C;

Figs. 7A through 7C are views for explaining a type determination mechanism of a mounted battery pack;

Fig. 8 is a flow chart showing a processing sequence of the power control CPU on the basis of the type determination in Fig. 7;

Fig. 9 is a block diagram showing an embodiment wherein the capacity of a mounted battery pack is detected, and battery pack charge current control is performed using a charge control parameter corresponding to the detected capacity type;

Figs. 10, 11A, and 11B are views for explaining an interface mechanism of a memory card used as an extension RAM in the above embodiment;

Figs. 12 and 13 and Figs. 14A to 14D are views for explaining a system grade-up means using a built-in HDD interface (HDD-IF) in the above embodiment; and

Fig. 15 is a view showing a bottom-up menu for displaying a battery state in the above embodiment.

Fig. 1 is a block diagram showing an embodiment of a personal computer according to the present invention. Referring to Fig. 1, components 11 through 30 and 40 are connected to a system bus 10. A CPU (main CPU) 11 controls the overall operation of the system. A ROM 12 stores permanent programs such as firmware. A RAM 13 serves as a main memory and stores programs and data to be processed. A direct memory access controller (DMAC) 14 performs direct memory access control. A programmable interrupt controller (PIC) 15 and a programmable interval timer (PIT) can be set by programs. A real time clock (RTC) 17 has its own operating battery. An extension RAM 18 serves as a high-capacity extension RAM to be detachably inserted in an extension RAM card slot. In this embodiment, any four types of memory cards, i.e., 4- and 8-MB new memory cards in addition to 1- and 2-MB existing memory cards, can be mounted. In this case, a common interface mechanism for the existing memory cards (1 MB and 2 MB) and the new memory cards (4 MB and 8 MB) will be described later with reference to Figs. 9 and 10.

A backup RAM 19 serves as a data storage area for realizing a resume function and is powered by a backup power (VBK). A floppy disk controller (FDC) 20 is arranged to control two floppy disk drives FDD(1) 32A and FDD(2) 32B. However, for example, a 2.5" hard disk may be mounted in place of the FDD(2) 32B, and the system can be easily graded up. In this case, a means for replacing the FDD + FDD arrangement with the HDD + FDD arrangement will be described later with reference to Figs. 12 through 14C.

A printer controller (PRT-CONT) 21 is selectively connected to a 5" external floppy disk drive 33 or a printer 34 through a connector. An input/output interface (Universal Asynchronous Receiver/Transmitter: UART) 22 is connected to an RS-232C interface 35 or the like as needed. A keyboard controller (KBC) 23 controls inputs to a keyboard 36 integrally arranged with an apparatus main body having a CPU board therein. A display controller (DISP-CONT) 24 drives only an LCD 37 with a side light consisting of an FL (fluorescent light) cold cathode ray tube. However, the DISP-CONT 24 may control a CRT display unit as an external display. A video RAM (VRAM) 25 is powered by the backup power (VBK) and stores video data. A kanji ROM 26 stores kanji character patterns corresponding to kanji character codes. A dictionary ROM 27 stores a kana/kanji conversion dictionary.

A power supply control interface (PS-IF) 28 is arranged to connect a power supply circuit (Fig. 2) 30 to the CPU 11 through the system bus 10. In this embodiment, the PS-IF 28 has a serial-parallel conversion function for performing data transfer by means of a serial interface between the power supply circuit 30 and the power control CPU 306 in this embodiment. A power supply adapter (to be referred to as an AC adapter) 29 is plug-in connected to the personal computer main body and rectifies and smoothes a commercial AC power (AC) to obtain a DC operating power having a predetermined potential. An intelligent power supply (to be referred to as a power supply circuit hereinafter) has the power control CPU (PC-CPU) and has an arrangement to be described with reference to Fig. 2.

Main batteries (M-BATA and M-BATB) 31L and 31R are detachable from the apparatus main body (PC main body) and are respectively constituted by rechargeable batteries. In this embodiment, during an operation, one of the batteries is selected as a target object (target power supply object) under the control of the power supply circuit 30. When the selected battery is discharged to a use limit, the target power supply object is switched, and the other battery serves as a target power supply object. In this embodiment, of the pair of main batteries (M-BATA and M-BATB) 31L and 31R, the battery (M-BATA) 31L is called a left main battery (L-battery), and the battery (M-BATB) 31R is called a right main battery (R-battery). In this case, main batteries having different capacities (i.e., 2200-mA type and 1700-mA type), and one of the batteries can be arbitrarily used. A charge control processing means for these main batteries (M-BATA and M-BATB) 31L and 31R will be described with reference to Fig. 3, and a selecting/switching processing means including a battery check during operation with a battery will be described later with reference to Figs. 4A through 4C. The charge control state display will be described later with reference to Figs. 5A and 5B, and the battery use state display and the state transition display will be described with reference to Fig. 6. At least one of the pair of main batteries (M-BATA and M-BATB) 31L and 31R is used as a detachable battery, battery packs serving as main batteries have two different current capacities, and any one of the battery packs can be mounted. Under these conditions, a mounted battery pack type determining mechanism and a charge processing means based on the determined battery type will be described later with reference to Figs. 7A through 8.

A sub-battery (S-BAT) 31S is a rechargeable built-in battery which supplies a backup power (VBK) required for backing up the RAM 13, the extension RAM 18, and the video RAM 25.

An extension bus connector 40 is an extension bus connector (EBC) for extending the functions. The EBC 40 is selectively connected to, e.g., an external hard disk (external HDD) as needed, or to any other extension unit having a function extension component (e.g., a keyboard, a CRT display, a high-capacity memory, and a personal computer mounting mechanism) to form a circuit.

A built-in HDD interface (HDD-IF) 41 interfaces a built-in HDD (with HDC) when the system is graded up to an HDD mounted type (i.e., one HDD and one FDD are mounted). More specifically, when the system is to be graded up, a built-up HDD is connected through a connector 42 in place of the floppy disk drive (FDD(2)) 32B. In this case, a means for grading up the system from the FDD + FDD type having two floppy disk drives (FDD(1) and FDD(2)) 32A and 32B to the HDD + FDD arrangement consisting of one 2.5" hard disk (HDD) and a 3.5" floppy disk drive will be described with reference to Figs. 12 through 14C.

A state display unit 50 consists of a plurality of sate display LEDs (L1 to L9) driven under the control of the power control CPU 306 in the power supply circuit 30, and the details of this state display unit are shown in Figs. 5A through 6C.

Fig. 2 is a block diagram showing an arrangement of the power supply circuit 30. The power supply circuit 30 includes a power switch 301, a reset switch 302, and a display switch 303. A switch 304 is used to set the capacity (2200-mA type or 1700-mA type) of the main battery (31L/31R) and is turned on to use the main battery (31L or 31R) having a larger capacity (2200 mA). A method of setting this switch 304 will be described in detail with reference to Figs. 7A through 7C. A parallel I/O port 305 holds states of the switches 301, 302, 303, and 304 and setup information of the power control CPU 306 (to be described in

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detail later).

The power control CPU (PC-CPU) 306 concentratedly manages the power supply of the overall apparatus. More specifically, the CPU 306 receives data of the respective components of the power supply circuit 30 instruction data of the CPU 11 through the internal bus 307 and controls power supply to the respective components in the apparatus in accordance with the instructions, internal states, and external operation states. The power control CPU 306 has a power supply control processing function including charge control of the left and right main batteries (M-BATA and M-BATB) 31L and 31R by using charge setup data (charge control parameter) shown in the flow chart of Fig. 3 and battery drive control in accordance with the flow charts in Figs. 4A through 4C.

An I/O driver 308 controls FL (fluorescent light) of the LCD 37 under the control of the power control CPU 306 and drives the LEDs (L1 through L9) of the state display unit 50.

As shown in Figs. 5A and 5B and Figs. 6A through 6C, the state display unit 50 consists of nine LEDs (L1 through L9) including a power ON state and operating speed set state display LED (L1), a state display LED (L2) for the left main battery (M-BATA) 31L, a state display LED (L3) for the right main battery (M-BATB) 31R, an AC adapter connecting state display LED (L4), a use state display LED (L5) for the floppy disk drive (FDD(1)) 32A, and a use state display LED (L6) for the floppy disk drive (FDD(2)) 32B. Each LED can emit red light and green light. Red light or green light, or both the green light and the red light are selectively emitted to perform display operations in units of colors. More specifically, the LED (L1) emits green light in a high-speed clock operation in a power ON state, but emits red light in a low-speed clock operation. The LEDs (L2 and L3) flickers red light when the corresponding main batteries (M-BATA and M-BATB) 31L and 31R are set in a low-battery state (i.e., a discharge state near a use limit), emit yellow light (red+green) in an abrupt charging state, and emit green light at the end of charging. The LED (L4) emits red light in an effective connecting state of the AC adapter 29 and flickers red light in the effective connecting state of the AC adapter 29 in an abnormal state of the power supply circuit 30.

A main battery switch (SL1) 309 is inserted in a current path of the left main battery (M-BATA) 31L and is ON/OFF-controlled by an output from the I/O driver 308 controlled by the power control CPU 306. Main battery switches (SR1 and SR0) 310a and 310b are inserted in a current supply path and a current output path of the right main battery (M-BATB) 31R, respectively, and is ON/OFF-controlled by an output from the I/O driver 308. A charge unit 311 charges main batteries (M-BATA and M-BATB) 31L and 31R under the control of the power control CPU 306. A current detector 312 detects output currents from the main batteries (M-BATA and M-BATB) 31L and 31R. Diodes 313 and 314 serve as reverse flow preventive diodes inserted in the current output paths of the main batteries (M-BATA and M-BATB) 31L and 31R. A DC-DC converter 315 generates operating powers for the respective components of the apparatus from the power source of the left main battery (M-BATA) through the main battery switch 309 or the right main battery (M-BATB) 31R through the main battery switches 310a and 310b. A charge unit 316 charges the sub-battery (S-BAT) 31S. A DC-DC converter 317 obtains a backup power (VBK) from a power supply of the sub-battery (S-BAT). In other words, since the left and right main batteries 31L and 31R are detachable, the backup power is supplied from the sub-battery (S-BAT) 31S to prevent erasure of the contents of the backup RAM 19 when both main batteries are detached from the main body. An A/D converter 318 supplies a detection current value of the current detector 312, the output voltages from the main batteries (M-BATA and M-BATB) 31L and 31R, and the output voltages from the DC-DC converters 315 and 317 to the power control CPU 306 as digital data. A serial I/O 319 exchanges data between the power control CPU 306 and the main CPU 11. More specifically, the I/O 319 converts data from the power control CPU 306 into serial data and supplies the digital data to the power supply control interface (PS-IF) 28. This serial data is reconverted into parallel data by the power supply control interface (PS-IF), and the parallel data is sent to the main CPU 11.

Figs. 3 and 4A through 4C are flow charts showing processing of the power control CPU 306. Fig. 3 is a flow chart showing a charge control routine in the embodiment of the present invention under the control of the power control CPU 306. This charge control processing is repeatedly performed every predetermined time interval (e.g., 64 msec) when the power control CPU 306 detects the connecting state of the AC adapter 29 through the A/D converter 318. Figs. 4A through 4C are flow charts showing power ON processing routine when the apparatus is driven by a battery (i.e., an operation performed when the AC adapter is not connected) under the control of the power control CPU 306. This power ON processing routine is repeated every predetermined time interval in a battery-driven power ON state.

Figs. 5A and 5B are views showing display contents of the state display unit 50 in association with charge control shown in Fig. 3. A relationship between the display contents and display colors of the state display LED (L2) for the left main battery

(M-BATA) 311, the state display LED (L3) for the right main battery (M-BATB) 31R, and the AC adapter connecting state display LED (L4) under the charge control in which an external power is supplied from an AC adapter is shown in Figs. 5A and 5B.

Figs. 6A through 6C are views showing display contents of the state display unit 50 in association with battery-driven control shown in Figs. 4A through 4C. These display contents of use states and state transition states are those of the LEDs (L2 through L4) which are obtained when an external power is not supplied from the AC adapter and one of the main batteries (M-BATA and M-BATB) 31L and 31R is selected to obtain a battery-driven state. In this embodiment, the right main battery is preferentially used. However, when the right main battery is set in a low-battery state or when the right main battery is not mounted, the left main battery is used.

Figs. 7A through 7C show an arrangement in which one of the main batteries (M-BATA and M-BATB) 31L and 31R is semi-fixed by a screw (in this case, the left main battery (M-BATA) 31L), the right main battery (M-BATB) 31R is slidably detachable by a slidable mounting means, and battery packs having two different current capacities (2200-mA high-capacity type and 1700-mA low-capacity type) can be arbitrarily used, so as to explain a type (capacity type) determination mechanism of the detachable battery pack (right main battery (M-BATB) 31R). Fig. 8 shows a set data (charge control parameter) switching processing flow of the power control CPU 306 by using a battery high capacity switch 304. In this case, the switch 304 is used to set the capacity of the semi-fixed battery pack (left main battery (M-BATA) 31L).

In this embodiment, of the pair of main batteries (M-BATA and M-BATB) 31L and 31R, one main battery (in this case, the left main battery (M-BATA) 31L) is semi-fixed by a screw, and the other battery (i.e., the right main battery (M-BATB) 31R) is arbitrarily detachable by the sliding mounting means. As shown in Figs. 7A and 7B, the main batteries (M-BATA and M-BATB) 31L and 31R are constituted by battery packs having two different current capacities (2200-mA high-capacity type and 1700-mA low-capacity type). In this case, the charge control for the main batteries (M-BATA and M-BATB) 31L and 31R is performed on the basis of the setup data (charge control parameter) under the control of the power control CPU 306. In order to arbitrarily use the battery packs having two different current capacities, charge control must be performed on the basis of the setup data (charge control parameter) corresponding to the capacity types of the mounted battery packs. In this embodiment, the battery high capacity switch 304 is operated to set a capacity type of a mounted battery pack as the battery pack semi-fixed by a screw, i.e., the left main battery (M-BATA) 31L in accordance with the capacity type of the mounted battery pack. A setup data (charge control parameter) switching processing means of the power control CPU 306 on the basis of the battery high capacity switch 304 is shown in the flow chart of Fig. 8. The capacity type of the mounted battery pack is automatically detected and the setup data (charge control parameter) is automatically switched for the battery pack arbitrarily detachable by the sliding mounting means, i.e., the right main battery (M-BATB) 31R. More specifically, in the battery pack used as the right main battery (M-BATB) 31R, a switch operation projection 70 is formed at a distal end portion at a predetermined position in a mounting direction (i.e., a direction of an arrow in Fig. 7B) in the 1700-mA low-capacity type battery pack. When the battery pack is mounted in the apparatus main body (PC main body), the switch 304 is turned on by the projection 70. The power control CPU 306 determines the capacity type of the mounted battery pack on the basis of the ON signal from the switch 304. The power control CPU 306 performs charge current control of the battery pack as the right main battery (M-BATB) 31R by using setup data (charge control parameter) corresponding to the detected capacity type.

This charge current control will be described with reference to Fig. 9.

Fig. 9 is a block diagram showing the PC-CPU 306 shown in Fig. 2 and its peripheral circuits.

As shown in Fig. 9, the battery 31R (31L) comprising a battery unit consisting of a plurality of primary or secondary batteries supplies a drive power to a load of electronic equipment through a control circuit 306C. Voltage and current values of the power supplied from the battery 31R (31L) to the load are measured by a measuring circuit 103. The measured data are converted into digital data by the A/D converter 306B, and the digital data is supplied to a microcomputer 306a. The battery 31R (31L) comprises a battery detector 107 for detecting a primary battery, a secondary battery, or their high-capacity batteries. When the battery 31R (31L) is mounted in a battery storage section (not shown) of the electronic equipment, the battery detector 107 cooperates with a battery determination section 105 located in the battery storage section opposite to the battery detector 107. A battery determination signal is supplied to the microcomputer 306a. The battery detector 107 comprises the projection shown in Fig. 7B and the switch 304 shown in Fig. 2.

The power can be supplied to the load of the

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electronic equipment from the AC adapter 29 in addition to the battery 31R (31L). When the AC adapter 29 is connected to the main body, a drive power is supplied from the AC adapter 29 to the load through the control circuit 306C. In this case, the drive power is not supplied from the battery 31R (31L) to the load. When the secondary battery is mounted as the battery 31R (31L), the charge power is supplied from the AC adapter 29 to the battery 31R (31L) through the control circuit 306C. When the battery 31R (31L) comprises a primary battery, no charge current is supplied.

A memory 306e including, e.g., a ROM is connected to the microcomputer 306a. The memory 306e stores battery characteristics including all types of batteries which can be used as batteries for driving the electronic equipment, and the charge and discharge voltage/current characteristics. These battery characteristics are exemplified as a characteristic A as of the primary battery and a characteristic B as of the secondary battery. When a battery determination signal is input from the battery determination section 105 to the microcomputer 306a, a battery characteristic corresponding to the battery determination signal is output from the memory 306e to the microcomputer 306a. On the basis of the battery characteristic value corresponding to the battery determination signal and the measurement data input from the measuring circuit 103, the microcomputer 306a supplies a control signal for controlling a charge current of the battery 31 by the AC adapter 8 through a D/A converter 306d. When the remaining capacity of the battery 31R (31L) is low (i.e., a low-battery state), the microcomputer 306a generates an alarm to a user for electronic equipment by means of an alarm 107 consisting of display equipment. A low-battery detection method and a charge control method are described in U.S.S.N. 545,542 filed by the present assignee and entitled as "LOW-BATTERY STATE DETECTING SYSTEM AND METHOD FOR DETECTING THE RESIDUAL CAPACITY OF A BATTERY FROM THE VARIATION IN BATTERY VOLTAGE (filing date: June 29, 1990, Inventor: Ryozi Ninomiya) and U.S.S.N. 578,225 filed by the present assignee and entitled as "METHOD AND APPARATUS FOR BATTERY CONTROL" (filing date: September 6, 1990, inventor: Ryozi Ninomiya).

When the primary battery is mounted in the battery storage section of the electronic equipment, the voltage and current of the power supplied from the battery 31R (31L) to the load are measured by the measuring circuit 103. The measurement data are input to the microcomputer 306a. When the battery determination signal representing the primary battery and obtained by cooperation of the battery detector 107 and the battery determination section 105 is input to the microcomputer 306a, the microcomputer 306a reads out the characteristic A as the primary battery characteristic value from the memory 306e. The microcomputer 306a determines the remaining capacity of the battery A on the basis of the measurement data and the characteristic A. When the remaining capacity is low and reaches, e.g., 95% of the use range, the alarm unit 107 alarms that a timing for replacing the battery 31R (31L) due to the low remaining capacity is informed to the user. When the battery 31R (31L) is further consumed and reaches the use limit of the battery 31R (31L), an operation error of the electronic equipment may occur. In order to stop supply of power from the battery 31R (31L) to the load, a control signal for stopping discharge of the battery 31R (31L) is supplied from the microcomputer 306a to the control circuit 306c through the D/A converter 306d.

When the AC adapter 29 is connected to the main body, the power is supplied from the AC adapter 29 to the load, but is not supplied from the battery 31R (31L) to the load.

When the secondary battery is mounted as the battery 31R (31L), the characteristic B as the secondary battery characteristic value is read out from the memory 306e, and the operation is the same as the case wherein the primary battery is mounted. However, when the AC adapter 29 is connected, the following different operations are performed. That is, since the secondary battery is rechargeable, the AC adapter 29 supplies power to the load and a charge current to the battery 31R (31L). This charge current is controlled by the control signal output from the microcomputer 306a, and a charge current within the range of 0.1 C to 0.5 C (where C is the secondary battery capacity. For example, 1 C for the 1700-mA capacity battery requires an hour to charge it with a charge current of 1.7 A) is selected stepwise in accordance with the remaining capacity of the battery 31R (31L).

With the above arrangement, the battery pack having an arbitrary capacity type (i.e., 2200-mA high-capacity type or 1700-mA low-capacity type) can be used for the battery pack serving as the detachable right main battery (M-BATB) 31R without causing the user to pay attention to the capacity type. As for the semi-fixed left main battery (M-BATA) 31L, the capacity is set by the switch 403 at the time of pack mounting. It is possible to arrange an arbitrary battery capacity corresponding to an application purpose.

Figs. 10 through 11B are views for explaining a common interface mechanism for the existing 1- and 2-MB memory cards and the new memory cards (4 MB and 8 MB) mounted in place of only the existing memory cards (1 MB and 2 MB). Of the predetermined number of pins (e.g., 40 pins),

one power supply pin and one ground pin (two pins) of each of the memory cards (1 MB and 2 MB), and one (Ta) of the omitted pins is assigned to an increase in address of the new memory cards (4 MB and 8 MB), and the remaining pin (Tb) is assigned to the card determination. When a terminal Tb signal (SEL) is set at high level (SEL = "1"), a logic gate array for controlling the output of the incremented address (A9: the most significant bits of the 4- and 8-MB cards) is connected to the terminal Ta of the mounted memory card (4-or 8-MB new memory card).

Figs. 12 through 14D are views for explaining a means for grading up the system from the FDD + FDD type consisting of the two floppy disk drives (FDD(1) 32A and FDD(2) 32B) to the HDD + FDD type consisting of the 2.5" hard disk (HDD) and the 3.5" floppy disk drive, by using the built-in HDD interface (HDD-IF) 41. A CPU board 3, a keyboard 36, and the like are mounted on the personal computer main body (PC main body). An FDD + FDD type base housing (Fig. 14A) 1A having the two floppy disk drives (FDD(1) 32A and FDD(2) 32B) therein and an HDD + FDD type base housing (Fig. 14B) having the 2.5" hard disk (HDD) and the 3.5" floppy disk drive are prepared. The base housing 1A (Fig. 14A) is replaced with the base housing 1B (Fig. 14B) and the mounted hard disk is connected through a built-in HDD interface (HDD-IF) 41, thereby easily grading up the system to the HDD + FDD type system. In this case, as shown in Figs. 14C and 14D, the 2.5" hard disk (HDD) is housed in the same type of housing as that of the 3.5" floppy disk drive and is placed on a detachable tray 111. Upon operation of an eject button 112, the 2.5" hard disk can be placed on the detachable tray 111 or ejected therefrom. Details of this operation will be omitted.

Fig. 15 is a view showing a pop-up menu for a battery state display. In this embodiment, upon simultaneously depression of a specific key such as a function key and an escape key, a battery state is displayed on part of the screen. In this case, in display areas (<LEFT>E••F and <RIGHT>E••F) for the left and right main batteries (M-BATA and M-BATB) 31L and 31R, when the batteries are not mounted, "N/A" is displayed. A battery mounted state (i.e., a state prior to charging) is displayed as "???". When charging of the battery is started, the present battery capacity is displayed with triangular marks (a maximum of seven triangle marks) in place of the battery mounted state "???".

An operation of the embodiment having the above arrangement according to the present invention will be described with reference to Figs. 1 through 15.

The power control CPU 306 in the power supply circuit 30 always monitors the operating state of the power switch 301. That is, the power control CPU 306 performs the power supply control processing routine regardless of the ON/OFF sate of the power supply of the apparatus. In an operation using the AC adapter (in a power ON state), the power control CPU 306 performs a charge control routine (Fig. 3) including charge processing using the charge control data (charge control parameter) based on setup at the battery high capacity switch 304. In a battery-driven state wherein the AC adapter is not connected, a power ON processing routine shown in Figs. 4A and 4B is performed.

In the power off state of the apparatus, when the power switch 301 is operated, its switching state is held in the parallel I/O port 305. This state is fetched at a predetermined processing timing by the power control CPU 306, thereby detecting that the power switch 301 has been operated. In this case, the operation of the power switch 301 is detected every period, and a counter is updated every cycle. When the updated count reaches a predetermined value, the power control CPU 306 determines that the power switch 301 is turned on to power the apparatus.

An operation (power ON state) using the AC adapter will be performed in accordance with the charge control routine shown in Fig. 3.

In this case, an external operation power (DC-IN) is supplied from the AC adapter 29 to the apparatus. This external power supply state is fetched by the power control CPU 306 through the A/D converter 318 and the internal bus 307 and is detected by the power control CPU 306. Under the control of the power control CPU 306, the AC adapter connecting state display LED (L4) in the state display unit 50 emits red light through the parallel I/O port 305 and the I/O driver 308, thereby displaying an effective connecting state of the AC adapter 29 by means of the LED (L4) (step S1 in Fig. 3; Fig. 5B).

When an external operating power is supplied from the AC adapter 29, it is determined whether the right main battery (M-BATB) 31R is mounted (step S1 in Fig. 3). If YES in step S1 in Fig. 3, the main battery switch (SL1) 309 is turned off, and the main battery switch (SR1) 310a is turned on. The charge unit 311 is controlled to charge the right main battery (M-BATB) 31R (step S3 in Fig. 3).

In this case, the state display LED (L3) for the right main battery (M-BATB) 31R is emits yellow red + green) light, thereby indicating that the right main battery (M-BATB) 31R is being charged (step S4 in Fig. 3; Fig. 5B).

When the right main battery (M-BATB) 31R is fully charged by the above charge control and this full charged state is detected (step S5 in Fig. 3), the state display LED (L3) for the right main battery

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(M-BATB) 31R emits green light (red OFF/green ON). The LED (L3) indicates that charging of the right main battery (M-BATB) 31R has been completed (step S6 in Fig. 3; Fig. 5B).

When charging of the right main battery (M-BATB) 31R is completed, the main battery switch (SR1) 310a is turned off (step S7 in Fig. 3).

When it is determined that the right main battery (M-BATB) 31R is not mounted in accordance with the mounting state (step S2 in Fig. 3) of the right main battery (M-BATB) 31R, it is then determined whether the left main battery (M-BATA) 31L is mounted (step S8 in Fig. 3). If YES in step S8 in Fig. 3, the main battery switch (SL1) 309 is turned on and the main battery switch (SR1) 310a is turned off. The left main battery (M-BATA) 31L is charged by the charge control of the charge unit 311 (step S9 in Fig. 3).

In this case, the state display LED (L2) for the left main battery (M-BATA) 31L emits yellow (red + green) light. This LED (L2) indicates that the left main battery (M-BATA) 31L is being charged (step S10; Fig. 5B).

During charging of the left main battery (M-BATA) 31L, the power control CPU 306 controls the charging unit 311 on the basis of the setup data (charge control parameter) based on the contents of the battery high capacity switch 304 to charge the left main battery (M-BATA) 31L at high speed in optimal conditions. This processing operation will be described later. By the above charge control, when the left main battery (M-BATA) 31L is fully charged and this full charged state is detected (step S11 in Fig. 3), the state display LED (L2) for the left main battery (M-BATA) 31L emits green light (red OFF/green ON). This LED (L2) indicates that charging of the left main battery (M-BATA) 31L has been completed (step S12 in Fig. 3; Fig. 5B).

When charging of the left main battery (M-BATA) 31L is completed, the main battery switch (SL1) 309 is turned off (step S13 in Fig. 3).

When the external operation power (DC-IN) is supplied from the AC adapter 29, charge control of the left and right main batteries (M-BATA and M-BATB) 31L and 31R is performed under the control of the power control CPU 306. Therefore, an optimal charged state can always be maintained.

A power ON processing operation in a battery-driven state (operation performed when the AC adapter is not connected) will be described with reference to Figs. 4A through 4C.

In the battery-driven state, since the AC adapter 29 is not connected, the AC adapter connecting state display LED (L4) is kept off (Figs. 6b and 6C).

In this routine, it is determined whether the power switch 301 has been depressed for a predetermined period of time (step S20 in Fig. 4A). If YES in step S20, it is determined whether the apparatus main body is currently set in a power ON state.

If YES (i.e., power ON state) in step S22 in Fig. 4A), a power OFF routine (not shown) is performed.

If a power OFF state is determined, it is determined whether the left main battery (M-BATA) 31L is set in a power voltage state enough to maintain a normal state (step S23 in Fig. 4A). If YES in step S23 in Fig. 4A, the LED (L4) is turned off (step S26 in Fig. 4A). It is determined whether the power ON operation is started by one of the left and right main batteries (M-BATA and M-BATB) 31L and 31R (step S27 in Fig. 4A).

In this state, since the left main battery (M-BATA) 31L is set in the power voltage state enough to maintain the normal operation, this battery power is supplied to the DC-DC converter 315. The respective operating powers are generated by the DC-DC converter 315 on the basis of the input battery power (power ON by the left main battery (M-BATA) 31L).

In the operation decision step (step S20 in Fig. 4A) for the power switch 301, when it is determined that the power switch 301 has not been depressed for the predetermined period of time, it is determined whether the power ON state is currently set (step S21 in Fig. 4A). If YES (power ON state) in step S21 in Fig. 4A, it is determined whether the left main battery (M-BATA) 31L is set in a power supply voltage state enough to maintain a normal operation (step S23 in Fig. 4A). If YES in step S23 in Fig. 4A, the LED (L4) is turned off (step S26 in Fig. 4A), and it is determined whether the power ON operation is started by one of the left and right main batteries (M-BATA and M-BATB) 31L and 31R (step S27 in Fig. 4A).

In the power supply voltage state check for the left main battery (M-BATA) 31L (step S23 in Fig. 4A), it is determined that the power supply voltage state cannot maintain a normal operation by the left main battery (M-BATA) 31L, i.e., the low-battery state is determined, it is determined whether the right main battery (M-BATB) 31R is set in a power supply voltage state enough to maintain the normal operation (step S24 in Fig. 4A). If YES in step S24 in Fig. 4A, the main battery switch (SRO) 310b is turned on (step S25 in Fig. 4A), and the LED (L4) is turned off (step S26 in Fig. 4A). It is determined whether the power ON operation is started by one of the left and right main batteries (M-BATA and M-BATB) 31L and 31R (step S27 in Fig. 4A).

In this case, since the main battery switch (SRO) 310b is turned on, the power of the right main battery (M-BATB) 31R is supplied to the DC-DC converter 315. The DC-DC converter 315 generates the respective operating powers on the basis of the input battery power. In this case, the reverse flow preventive diode 313 prevents a flow

of the power from the right main battery (M-BATB) 31R to the left main battery (M-BATA) 31L.

In the decision step of the power ON battery (step S27 in Fig. 4A), it is determined that the power ON operation is started by the left main battery (M-BATA) 31L, the state display LED (L2) for the left main battery (M-BATA) 31L emits green light (red OFF/green ON). This LED (L2) indicates that the left main battery (M-BATA) 31L is selected and being used (step S28 in Fig. 4A; Fig. 6B). It is determined whether the left main battery (M-BATA) 31L is set in a low-battery state (step S29 in Fig. 4B). If YES in step S29 in Fig. 4B, it is determined whether the right main battery (M-BATA) 31R is mounted (step S30 in Fig. 4B).

If the right main battery (M-BATB) 31R is mounted, it is determined whether this battery has a power supply voltage state enough to maintain a normal operation (step S31 in Fig. 4B). If YES in step S31 in Fig. 4B, the main battery switch (SR0) 310b is turned on. The power from the right main battery (M-BATB) 31R is supplied to the DC-DC converter 315. The DC-DC converter 315 generates the respective operating powers on the basis of the input battery power (step S32 in Fig. 4B).

In this case, the state display LED (L2) for the left main battery (M-BATA) 31L is turned off to stop emitting red light (red ON/green OFF). The LED (L2) indicates that the left main battery (M-BATA) 31L is set in a low-battery state which requires charging (step S33 in Fig. 4B; Fig. 5C). The state display LED (L3) for the right main battery (M-BATB) 31R emits green light (red OFF/green ON). This LED (L3) indicates that the right main battery (M-BATB) 31R is selected and being used (step S34 in Fig. 4B; Fig. 6B).

In the decision step (step S30 in Fig. 4B) for the presence/absence of the right main battery (M-BATB) 31R, when it is determined that the right main battery (M-BATB) 31R is not mounted, or in the decision step (step S31 in Fig. 4B) for the right main battery (M-BATB) 31R, when the right main battery (M-BATB) 31R is set in a low-battery state which requires charging, the state display LED (L2) for the left main battery (M-BATA) 31L flickers red light (red flicker/green OFF). The LED (L2) indicates that the left main battery (M-BATA) 31L is set in the low-battery state which requires charging and at the same time that driving using the battery is impossible (step S39 in Fig. 4B; Fig. 5C).

In the power ON battery discrimination (step S27 in Fig. 4A), it is determined that the right main battery (M-BATB) 31R is selected and being used, the state display LED (L3) for the right main battery (M-BATB) 31R emits green light (red OFF/green ON). This LED (L3) indicates that the right main battery (M-BATB) 31R is selected and being used (step S34 in Fig. 4B; Fig. 6B). It is determined whether the right main battery (M-BATB) 31R is set in a low-battery state (step S35 in Fig. 4B).

When the right main battery (M-BATB) 31R is set in the low-battery state, the absence of the left main battery (M-BATA) 31L is determined (step S36 in Fig. 4B). If the left main battery (M-BATA) 31L is mounted, it is determined whether the left main battery (M-BATA) 31L is set in a power supply voltage state enough to maintain a normal operation (step S37 in Fig. 4B).

When the left main battery (M-BATA) 31L is set in the power supply voltage state enough to maintain the normal operation, the state display LED (L2) for the right main battery (M-BATB) 31R emits red light (red ON/green OFF). The LED (L2) indicates that the right main battery (M-BATB) 31R is set in the low-battery state which requires charging (step S38 in Fig. 4B; Fig. 5C). The flow advances to the decision step (step S22 in Fig. 4A) for the power ON state.

In the decision step of determining whether the left main battery (M-BATA) 31L is mounted (step S30 in Fig. 4B), or in the decision step of determining the sate of the left main battery (M-BATA) 31L (step S31 in Fig. 4B), when it is determined that the left main battery (M-BATA) 31L is set in the low-battery state which requires charging, the LED (L3) for the right main battery (M-BATB) 31R flickers red light (red flicker/green OFF. This LED (L3) indicates that the right main battery (M-BATB) 31R is set in the low-battery state which requires charging and that the battery driving cannot be performed (step S40 in Fig. 4B; Fig. 5C).

The state display LED (L2) for the left main battery (M-BATA) 31L, or the state display LED (L3) for the right main battery (M-BATB) 31R flickers red light, a power OFF routine is started after a lapse of a preset time (three minutes in this case).

In a battery-driven state (i.e., an operation performed when the AC adapter is not connected), highly reliable operations driven by the battery can be assured for a long period of time by the power ON processing.

In this embodiment, of the pair of main batteries (M-BATA and M-BATB) 31L and 31R, one main battery is semi-fixed by a screw (in this case, the left main battery (M-BATA) 31L), and the other battery, i.e., the right main battery (M-BATB) 31R is arbitrarily detachable by the sliding mounting means. As shown in Figs. 7A and 7B, the main batteries (M-BATA and M-BATB) 31L and 31R are constituted by battery packs having different current capacities (in this case, the 2200-mA high-capacity type and the 1700-mA low-capacity type).

In this case, as described above, charge control of the main batteries (M-BATA and M-BATB) 31L and 31R is performed by the power control CPU 306 on the basis of the setup data (charge

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control parameter). In order to arbitrarily and selectively use the two different types of battery packs, charge current control must be performed on the basis of the setup data (charge control parameter) corresponding to the capacity types of the mounted battery packs.

For this purpose, in this embodiment, the main battery high capacity switch 304 is operated to set a capacity type of the mounted battery pack, i.e., the left main battery (M-BATA) 31L, in accordance with the capacity type of the mounted battery pack. In this case, the setup data (charge control parameter) switching processing means based on the battery high capacity switch 304 is shown in the flow chart of Fig. 8.

In charge control of the left main battery (M-BATA) 31L, the power control CPU 306 reads the content of the battery high capacity switch 304. The power control CPU 306 determines in accordance with the content whether the current capacity of the semi-fixed mounted battery pack is the 2200-mA high-capacity type or the 1700-mA low-capacity type and controls the charge unit 311 on the basis of the charge control setup data (charge control parameter) corresponding to the determined capacity type, thereby charging the left main battery (M-BATA) 31L at high speed in optimal conditions.

As for the battery pack detachable by the sliding mounting means, i.e., as for the right main battery (M-BATB) 31R, the capacity type of the mounted battery pack is automatically detected and the setup data (charge control parameter) can be automatically switched. That is, in the battery pack used as the right main battery (M-BATB) 31R, the switch operation projection 70 is mounted at the distal end portion at the predetermined position in the mounting direction (i.e., a direction of an arrow in Fig. 7B) in the 1700-mA low-capacity battery pack. A current capacity detection switch 71 operated by the projection 70 is mounted in the apparatus main body (PC main body). The power control CPU 306 detects the capacity type of the mounted battery pack on the basis of the signal from the switch 71 and performs charge control of the battery. pack as the right main battery (M-BATB) 31R by using the setup data (charge control data) corresponding to the capacity type.

With this arrangement, the battery pack having any capacity type (2200-mA high-capacity type or 1700-mA low-capacity type) for the detachable right main battery (M-BATB) 31R without causing the operator to pay attention to the capacity type. The battery high capacity switch 403 is once operated at the time of mounting of the pack as the left main battery (M-BATA) 31L. Therefore, any battery capacity configuration corresponding to an application purpose can be easily obtained.

In this embodiment, there is provided a function of displaying mounted states of the main batteries (M-BATA and M-BATB) 31L and 31R and their capacities (remaining capacities) in a pop-up menu shown in Fig. 15. Under the control of the power control CPU 306, in the display areas (<LEFT>E••F and <RIGHT>E••F), a battery non-mounted state is indicated by "N/A", a state in which a battery is mounted but not charged is indicated by "???". When battery charging is started, a present battery capacity is indicated with triangular marks (a maximum of seven triangular marks) in place of the battery mounted state

The mounted states and capacities (remaining capacities) of the pair of left and right main batteries (M-BATA and M-BATB) 31L and 31R can be easily checked by the pop-up menu.

In this embodiment, the 4- and 8-MB new memory cards can be mounted in addition to the 1- and 2-MB existing memory cards as the extension RAM 18. A common interface mechanism for the existing memory cards (1 MB and 2 MB) and the new memory cards (4 MB and 8 MB) is shown in Figs. 10, 11A, and 11B. Of the predetermined number of pins (e.g., 40 pins), one power supply pin and one ground pin (two pins) of each of the memory cards (1 MB and 2 MB), and one (Ta) of the omitted pins is assigned to an increase in address of the new memory cards (4 MB and 8 MB), and the remaining pin (Tb) is assigned to the card determination. When a terminal Tb signal (SEL) is set at high level (SEL = "1"), a logic gate array for controlling the output of the incremented address (A9: the most significant bits of the 4- and 8-MB cards) is connected to the terminal Ta of the mounted memory card (4- or 8-MB new memory card).

The 4- and 8-MB new memory cards can be used in addition to the 1- and 2-MB existing memory cards as the extension RAM 18, thereby easily and arbitrarily increasing the memory capacity.

In this embodiment, the system has the built-in HDD interface (HDD-IF) 41 and can be graded up from the FDD + FDD type having two floppy disk drives (FDD(1) 32A and FDD(2) 32B) into the HDD + FDD type having one 2.5" hard disk (HDD) and one 3.5" floppy disk drive by using this interface (HDD-IF) 41. More specifically, as shown in Figs. 12 to 14C, the FDD + FDD type base housing (Fig. 14A) 1A having the two floppy disk drives (FDD(1) 32A and FDD(2) 32B) therein and the HDD + FDD type base housing (Fig. 14B) having the 2.5" hard disk (HDD) and the 3.5" floppy disk drive are prepared. The base housing 1A (Fig. 14A) is replaced with the base housing 1B (Fig. 14B), and the mounted hard disk is connected through a built-in HDD interface (HDD-IF) 41, thereby easily grading up the system to the HDD + FDD type

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system. In this case, as shown in Figs. 14C and 14D, the 2.5" hard disk (HDD) is housed in the same type of housing as that of the 3.5" floppy disk drive and is placed on the detachable tray 111. Upon operation of an eject button 112, the 2.5" hard disk can be placed on the detachable tray 111 or ejected therefrom. Details of this operation will be omitted.

In the above embodiment, when the apparatus is set in the power OFF state, the power control CPU always monitors the operating state of the power switch 301 and the states of the power supplies and the apparatus and externally display the states of the power supplies and the apparatus in the power OFF routine. More specifically, in the power ON routine, when an extension board is not connected to an extension connector 40 or when the extension board connected to the extension connector 40 is confirmed not to be set in a ready state, the power ON processing is executed. A power supply state is determined in the same manner as in the power ON routine, the states of the respective components of the apparatus are determined, and these operations are repeated. During this repetition, when an abnormal sate of the power supply is detected, data which instructs to turn off the power supply is sent to the main CPU 11, and then power OFF processing is executed. In this power OFF processing, the respective power supplies in the apparatus except for the backup power (VBK) are cut off in a predetermined order upon reception of a response from the main CPU 11. The power OFF routine is then initiated. In this case, when the main CPU 11 receives the data which instructs to cut off the power supplies from the power control CPU 306 through the power supply control interface 28, the main CPU 11 recognizes the setup state of the resume function. When the resume function is set, resume processing using the backup RAM 19 is completed, and then response data is sent back to the power control CPU 306 through the power supply control interface 28.

The power control CPU 306 executes the power supply processing routine including charge control of the main batteries (M-BATA and M-BATB) 31L and 31R and the use state control. The power control CPU 306 always monitors the states of the power supplies including the main batteries (M-BATA and M-BATB) 31L and 31R and the apparatus power supply and externally displays their states.

The power control means according to the present invention is not limited to the system configuration shown in Fig. 1 but can be easily applied to another system configuration. The arrangement of the power supply circuit 30 is not limited to that of the above embodiment but may be constituted by another arrangement as a means for recognizing the states of the main batteries (M-BATA and M-BATB) 31L and 31R. In the above embodiment, the external operating power is not supplied. When the first and second main batteries are set in a rechargeable discharge limit state, the means for alarming this state by means of LEDs is exemplified. However, alarming may be performed by a combination of a visual display and a sound.

Claims

1. A personal computer having data storage means and data processing means, characterized by comprising:
battery pack storage means for storing any of battery packs (31L, 31R) having different current capacities;
means (312) for detecting a current capacity of a battery pack stored in said battery pack storage means;
means (306, 311) for charging the stored battery pack on the basis of the current capacity detected by said detecting means; and
means (315) for generating an operating power from the battery pack stored in said battery pack storage means.

2. A computer according to claim 1, characterized in that said means for detecting the current capacity of the battery pack comprises set switch means (304) for setting the current capacities of the battery packs.

3. A computer according to claim 1, characterized in that said charging means comprises:
means (306e) for prestoring characteristic data of the battery packs having the different current capacities;
means (103) for detecting voltage and current values of the driven battery pack; and
charge control means (306, 311) for controlling charging of the battery pack on the basis of the characteristic data corresponding to the current capacity of the battery pack detected by said current capacity detecting means and the voltage and current values detected by said voltage/current detecting means.

4. A computer according to claim 1, characterized in that said battery pack storage means comprises:
at least two battery pack storage sections for respectively storing at least two battery packs; and
means for selecting one of said plurality of battery packs.

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5. A computer according to claim 4, characterized in that the battery pack stored in at least one of said battery pack storage sections is detachable.

6. A computer according to claim 5, characterized in that the current capacities of said at least two battery packs are equal to each other.

7. A computer according to claim 5, characterized in that the current capacities of said at least two battery packs are different from each other.

8. A computer according to claim 7, characterized by further comprising means for setting a current capacity of said at least one battery pack.

9. A computer according to claim 4, characterized in that said selecting means comprises:
means for detecting a low-battery sate of any one of the battery packs; and
means for replacing the battery pack in the low-battery state with the other battery pack.

10. A computer according to claim 4, characterized in that said means for detecting the current capacity of the battery pack comprises set switch means for setting the current capacity of the battery pack.

11. A computer according to claim 4, characterized in that said charging means comprises:
means (306e) for prestoring characteristic data of the battery packs having the different current capacities;
means (103) for detecting voltage and current values of the driven battery pack; and
charge control means (306, 311) for controlling charging of the battery pack on the basis of the characteristic data corresponding to the current capacity of the battery pack detected by said current capacity detecting means and the voltage and current values detected by said voltage/current detecting means.

12. A charge control system comprising:
a battery mounting section capable of receiving different types of batteries;
means for determining types of batteries mounted in said mounting section;
storage means for prestoring characteristic values of the different types of batteries;
means for detecting voltage and current values when driven by a battery; and
charge control means, responsive to the voltage and current values detected by said detecting means, for reading out the battery characteristic values from said storage means on the basis of the batteries determined by said determining means and for performing battery charge control on the basis of the readout characteristic values.

13. A personal computer utilizing the charge control system of claim 12.

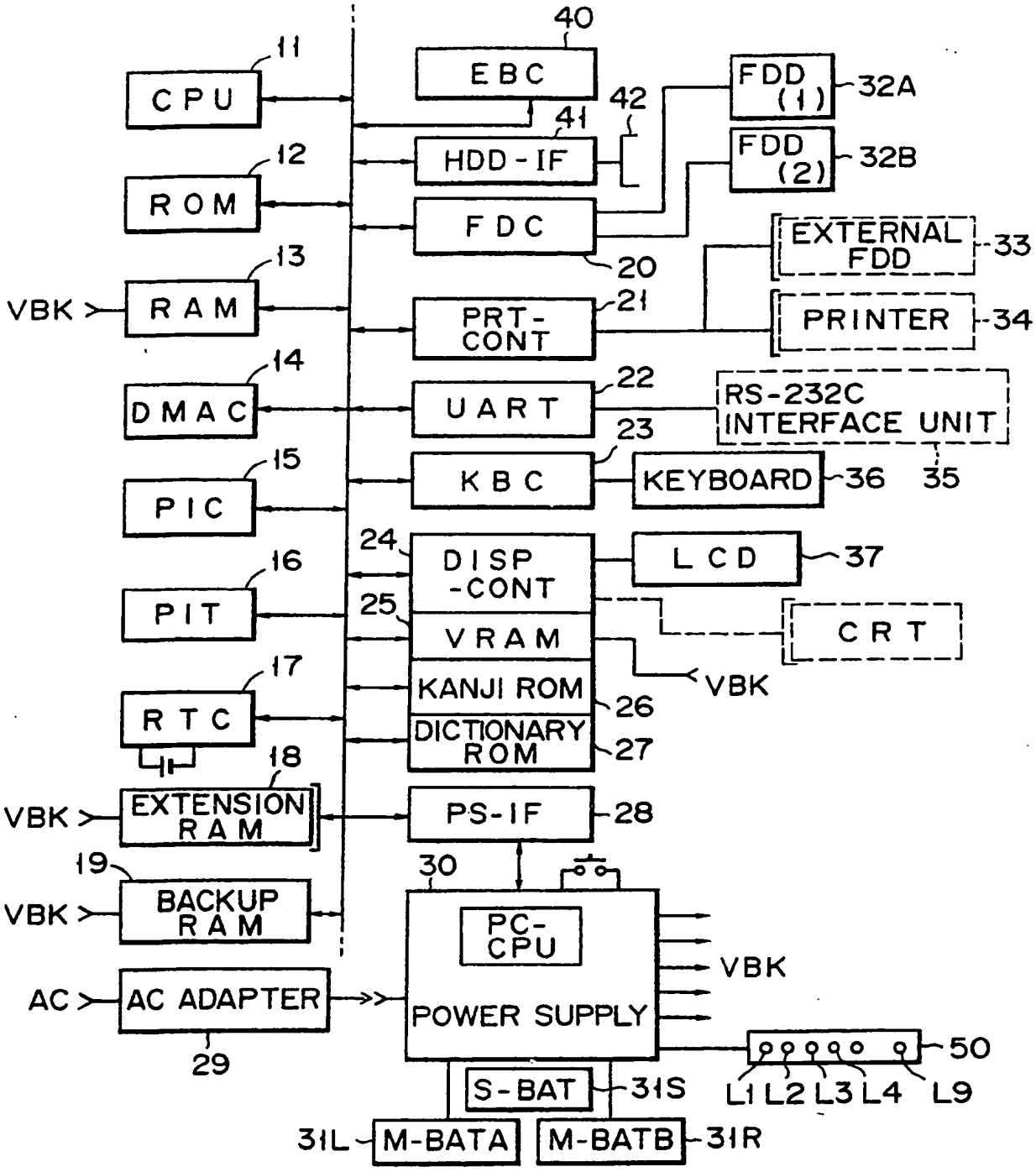
CPU
11
ROM
12
RAM
13
VBK
DMAC
14
PIC
15
PIT
16
RTC
17
EXTENSION RAM
18
VBK
BACKUP RAM
19
VBK
AC
AC ADAPTER
29
EBC
40
HDD-IF
41
42
FDC
20
PRT-CONT
21
UART
22
KBC
23
KEYBOARD
36
DISP-CONT
24
VRAM
25
KANJI ROM
26
DICTIONARY ROM
27
PS-IF
28
30
PC-CPU
POWER SUPPLY
VBK
FDD (1)
32A
FDD (2)
32B
EXTERNAL FDD
33
PRINTER
34
RS-232C INTERFACE UNIT
35
LCD
37
CRT
VBK
50
L1 L2 L3 L4 L9
S-BAT
31S
31L
M-BATA
M-BATB
31R

FIG. 1

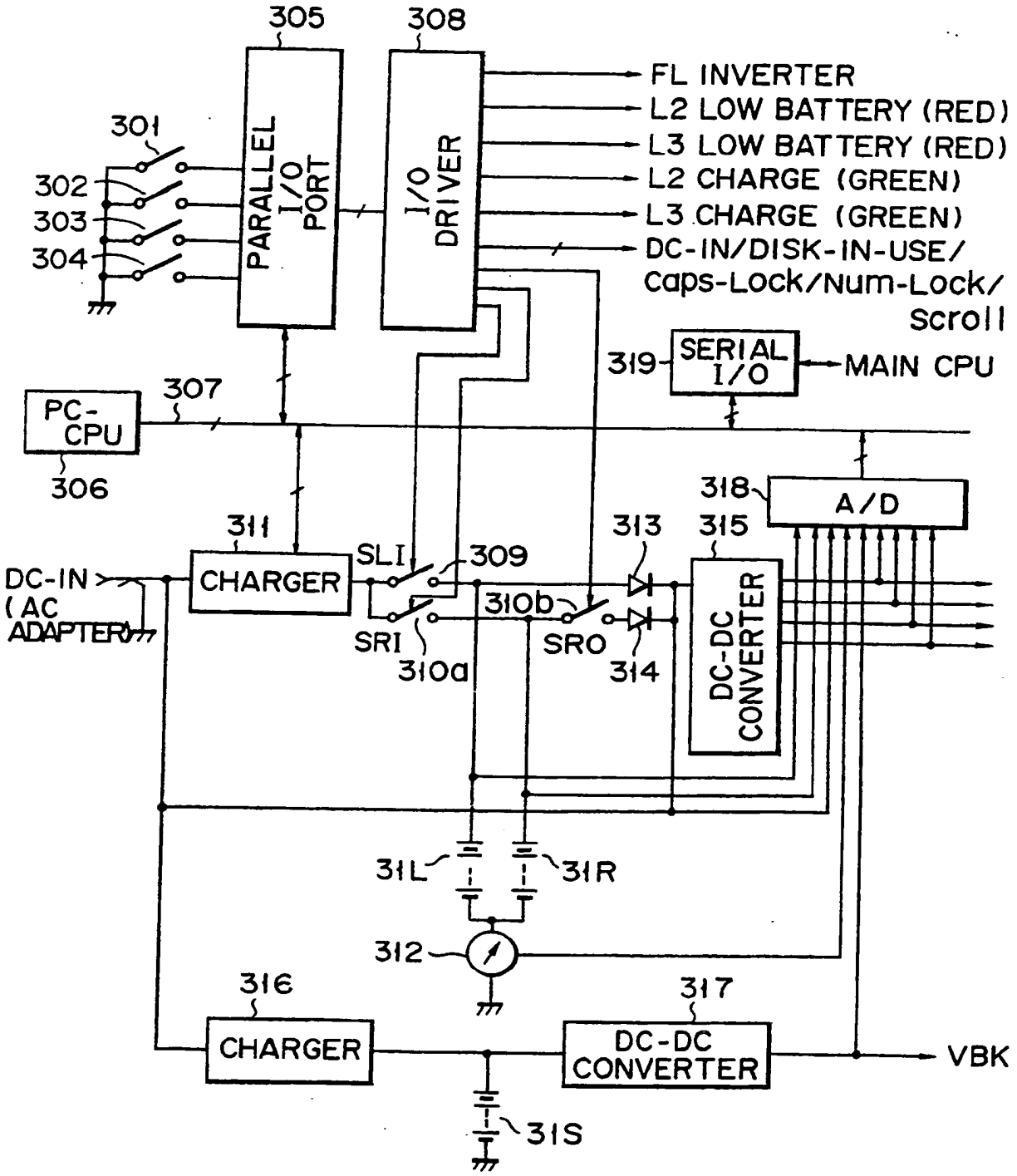
305
308
301
302
303
304
PARALLEL I/O PORT
I/O DRIVER
FL INVERTER
L2 LOW BATTERY (RED)
L3 LOW BATTERY (RED)
L2 CHARGE (GREEN)
L3 CHARGE (GREEN)
DC-IN/DISK-IN-USE/
Caps-Lock/Num-Lock/
Scroll
319
SERIAL I/O
MAIN CPU
307
PC-CPU
306
318
A/D
311
313
315
DC-IN (AC ADAPTER)
CHARGER
SLI
309
310b
SRI
310a
SRO
314
DC-DC CONVERTER
31L
31R
312
316
317
CHARGER
DC-DC CONVERTER
VBK
31S

FIG. 2

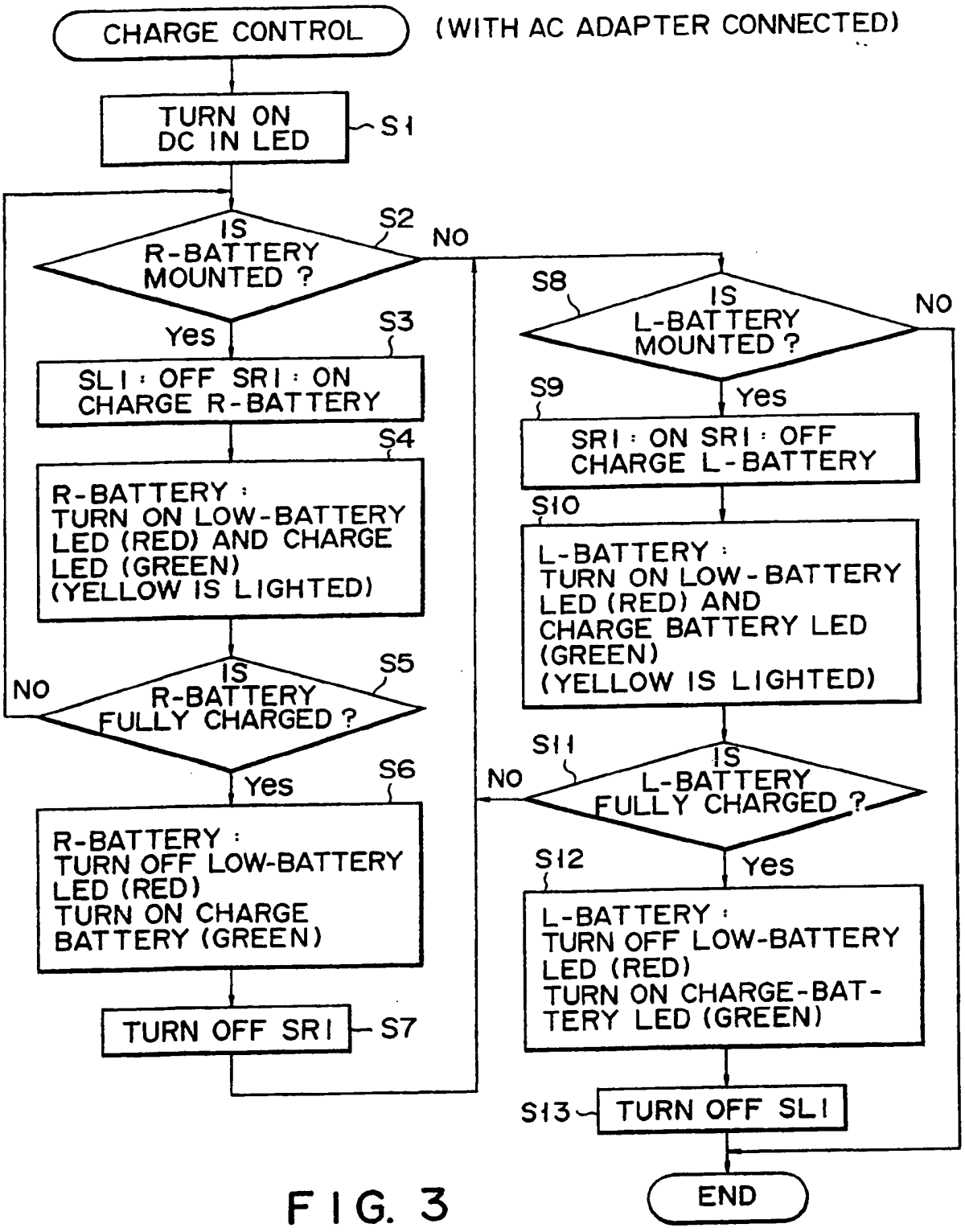
CHARGE CONTROL
(WITH AC ADAPTER CONNECTED)
TURN ON DC IN LED
S1
IS R-BATTERY MOUNTED ?
S2
NO
Yes
S3
SL1 : OFF SR1 : ON CHARGE R-BATTERY
S4
R-BATTERY : TURN ON LOW-BATTERY LED (RED) AND CHARGE LED (GREEN) (YELLOW IS LIGHTED)
IS R-BATTERY FULLY CHARGED ?
S5
NO
Yes
S6
R-BATTERY : TURN OFF LOW-BATTERY LED (RED) TURN ON CHARGE BATTERY (GREEN)
TURN OFF SR1
S7
S8
IS L-BATTERY MOUNTED ?
NO
Yes
S9
SR1 : ON SR1 : OFF CHARGE L-BATTERY
S10
L-BATTERY : TURN ON LOW-BATTERY LED (RED) AND CHARGE BATTERY LED (GREEN) (YELLOW IS LIGHTED)
S11
IS L-BATTERY FULLY CHARGED ?
NO
Yes
S12
L-BATTERY : TURN OFF LOW-BATTERY LED (RED) TURN ON CHARGE-BATTERY LED (GREEN)
S13
TURN OFF SL1
END

FIG. 3

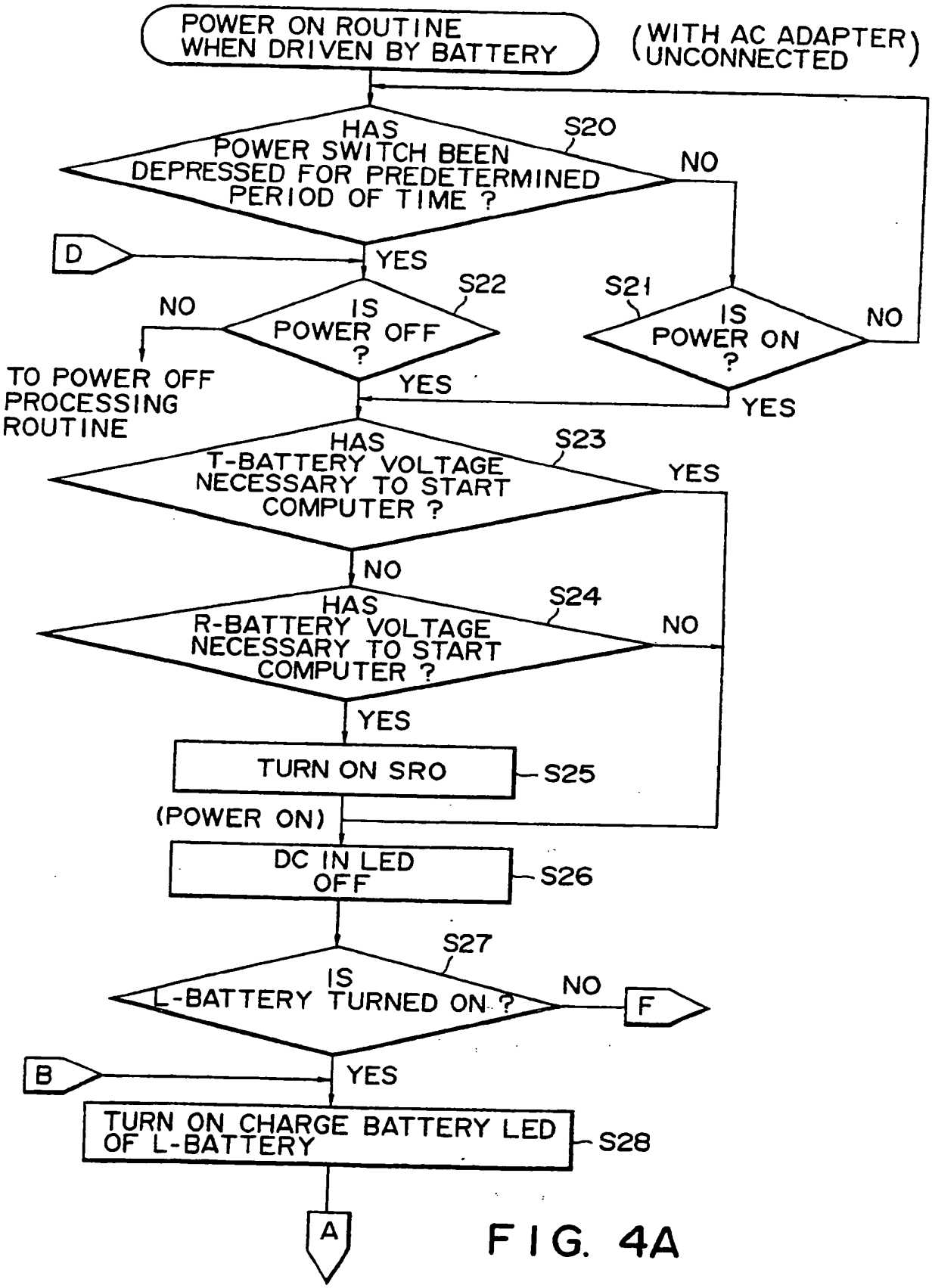
POWER ON ROUTINE WHEN DRIVEN BY BATTERY
(WITH AC ADAPTER UNCONNECTED)
HAS POWER SWITCH BEEN DEPRESSED FOR PREDETERMINED PERIOD OF TIME ?
S20
NO
D
YES
S22
S21
NO
IS POWER OFF ?
IS POWER ON ?
NO
TO POWER OFF PROCESSING ROUTINE
YES
YES
HAS T-BATTERY VOLTAGE NECESSARY TO START COMPUTER ?
S23
YES
NO
HAS R-BATTERY VOLTAGE NECESSARY TO START COMPUTER ?
S24
NO
YES
TURN ON SRO
S25
(POWER ON)
DC IN LED OFF
S26
S27
IS L-BATTERY TURNED ON ?
NO
F
B
YES
TURN ON CHARGE BATTERY LED OF L-BATTERY
S28
A

FIG. 4A

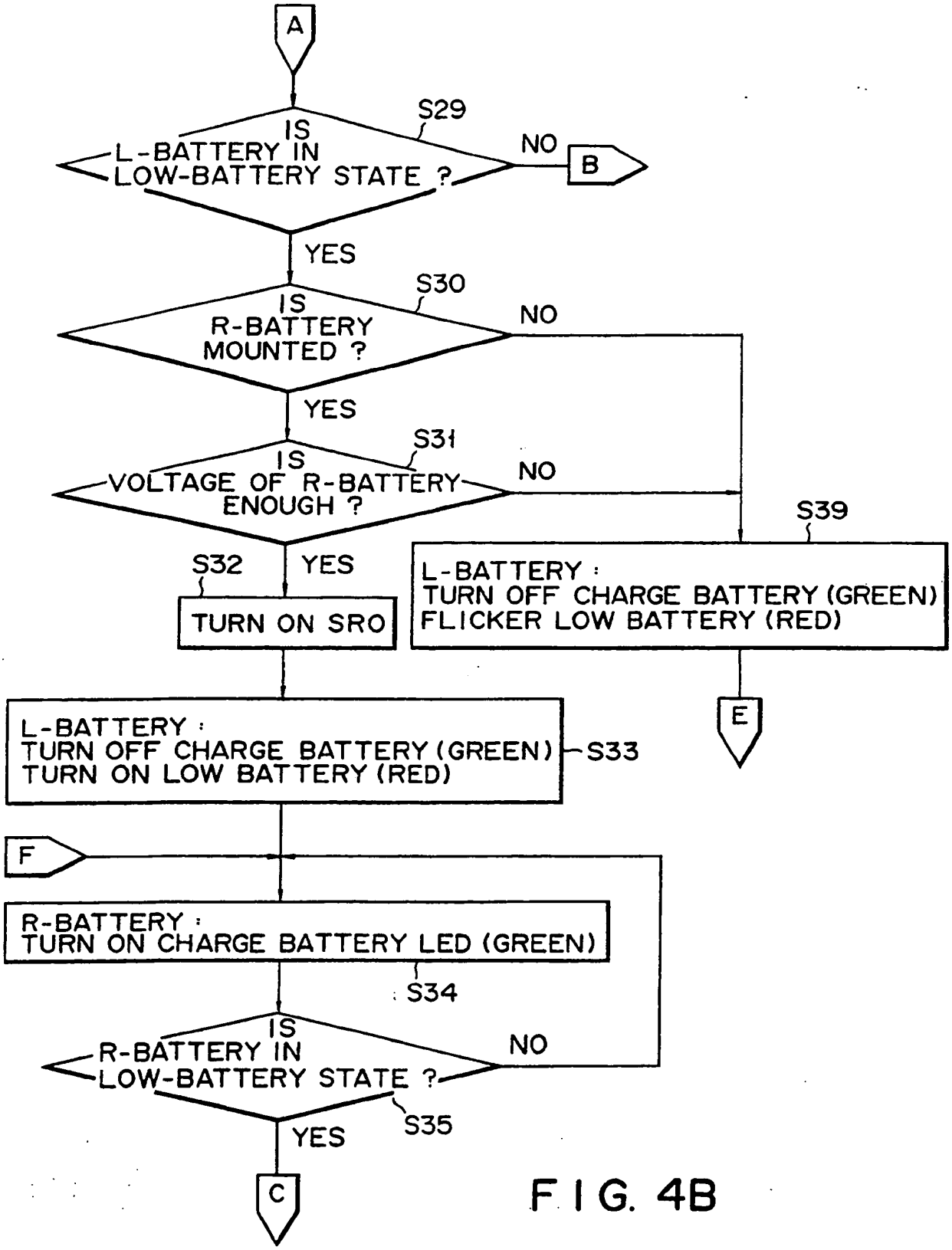
A
S29
IS
L-BATTERY IN
LOW-BATTERY STATE ?
NO
B
YES
S30
IS
R-BATTERY
MOUNTED ?
NO
YES
S31
IS
VOLTAGE OF R-BATTERY
ENOUGH ?
NO
S39
S32
YES
L-BATTERY :
TURN OFF CHARGE BATTERY (GREEN)
FLICKER LOW BATTERY (RED)
TURN ON SRO
E
L-BATTERY :
TURN OFF CHARGE BATTERY (GREEN)
TURN ON LOW BATTERY (RED)
S33
F
R-BATTERY :
TURN ON CHARGE BATTERY LED (GREEN)
S34
IS
R-BATTERY IN
LOW-BATTERY STATE ?
NO
S35
YES
C

FIG. 4B

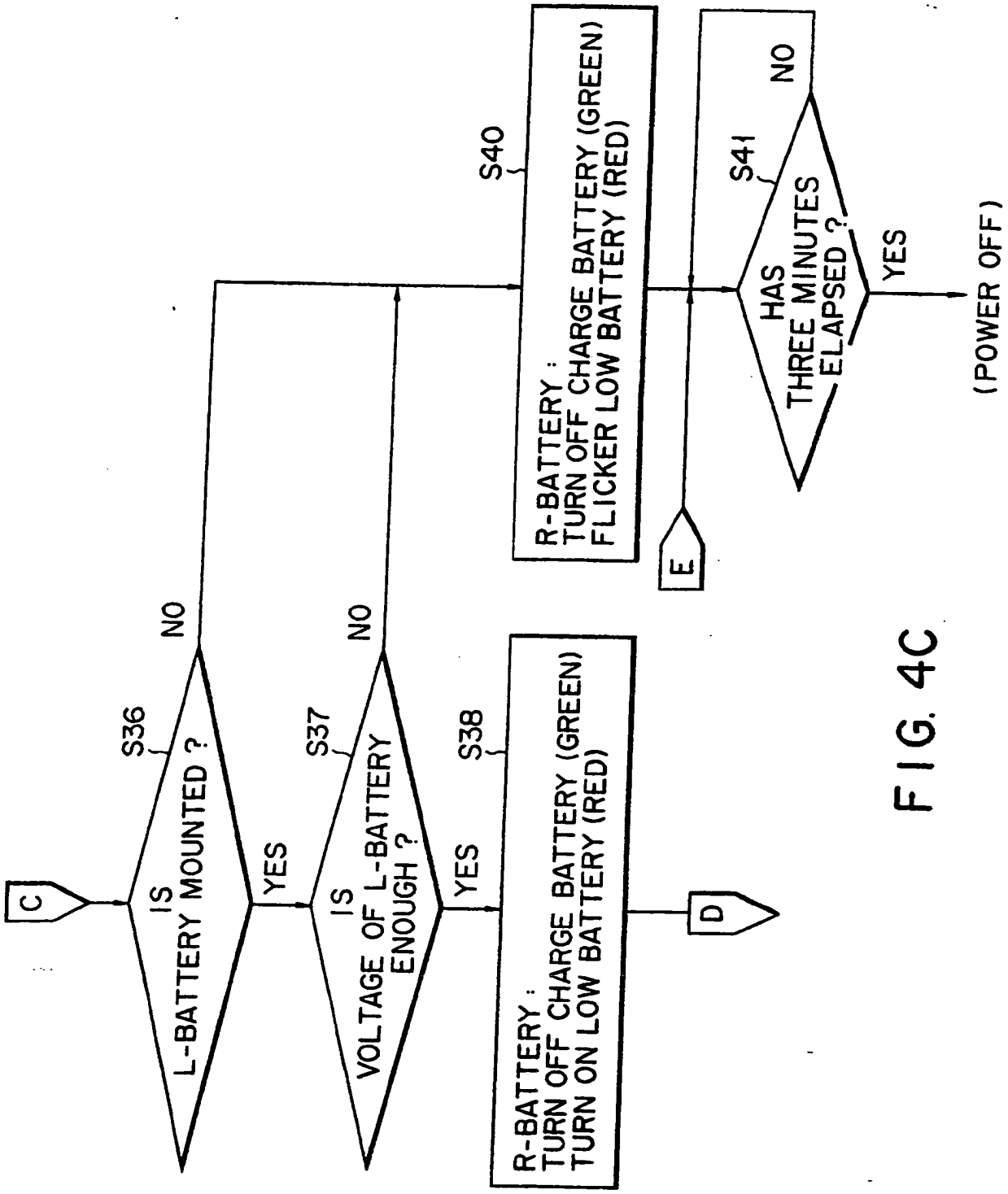
C
S36
IS L-BATTERY MOUNTED ?
NO
YES
S37
IS VOLTAGE OF L-BATTERY ENOUGH ?
NO
YES
S38
R-BATTERY : TURN OFF CHARGE BATTERY (GREEN) TURN ON LOW BATTERY (RED)
D
S40
R-BATTERY : TURN OFF CHARGE BATTERY (GREEN) FLICKER LOW BATTERY (RED)
E
S41
HAS THREE MINUTES ELAPSED ?
NO
YES
(POWER OFF)

FIG. 4C

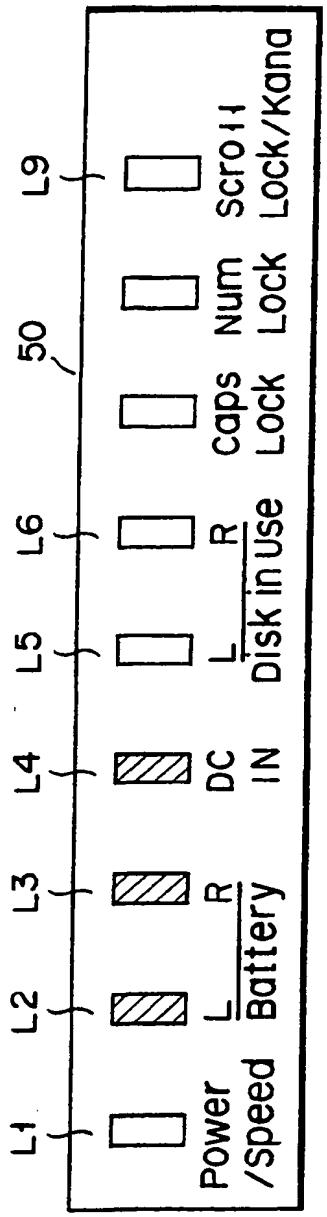

FIG. 5A

L R Battery	DC IN	STATE DISPLAY CONTENTS
	RED ON	AC ADAPTER IS CONNECTED (POWER IS SUPPLIED EXTERNALLY)
YELLOW ON	RED ON	R-BATTERY IS BEING CHARGED
GREEN ON	RED ON	CHARGING OF R-BATTERY IS COMPLETED
YELLOW ON	RED ON	L-BATTERY IS BEING CHARGED
GREEN ON	RED ON	CHARGING OF L-BATTERY IS COMPLETED

L2 L3 L4

FIG. 5B

RNSDOCID: <EP 0435317A2 I >

FIG. 6A

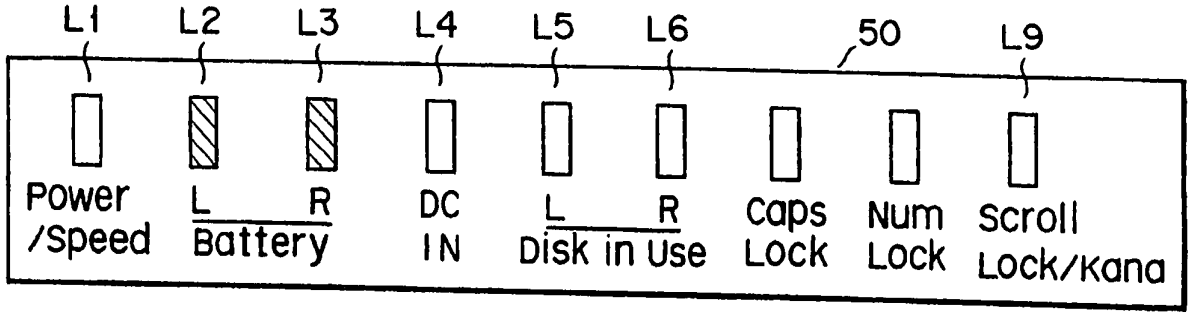

FIG. 6B

L R Battery		DC IN	STATE DISPLAY CONTENTS
OFF	GREEN ON	OFF	MAIN BODY IS BEING DRIVEN WITH R-BATTERY
GREEN ON	OFF	OFF	MAIN BODY IS BEING DRIVEN WITH L-BATTERY
L2	L3	L4	

FIG. 6C

L R Battery			DC IN	STATE DISPLAY CONTENTS
	GREEN	ON	OFF	MAIN BODY IS BEING DRIVEN WITH R-BATTERY
	RED	ON	OFF	R-BATTERY IS USED UP CHARGING IS REQUIRED
GREEN ON	RED	ON	OFF	MAIN BODY IS BEING DRIVEN WITH L-BATTERY R-BATTERY IS USED UP CHARGING IS REQUIRED
RED FLICKER	RED	ON	OFF	L-BATTERY IS ALSO USED UP CHARGING IS REQUIRED R-BATTERY IS USED UP CHARGING IS REQUIRED
(POWER IS CUT OFF AUTOMATICALLY)				
L2	L3		L4	

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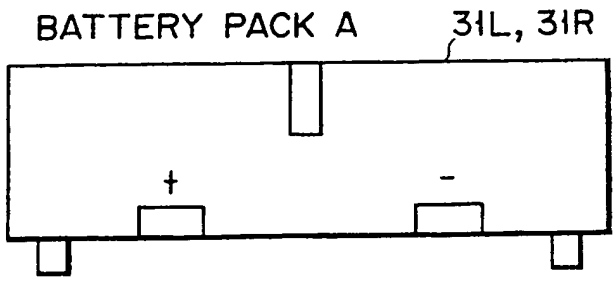


FIG. 7A

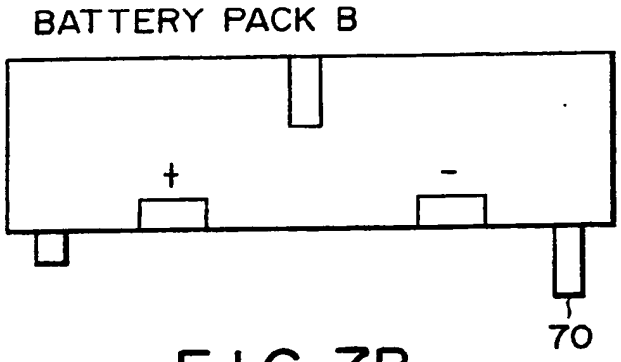


FIG. 7B

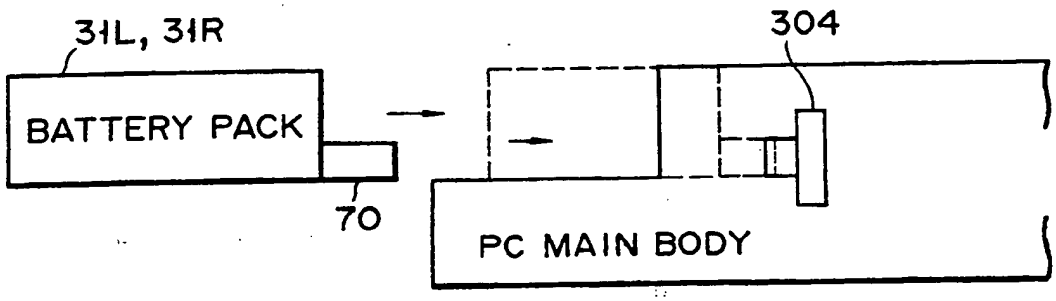


FIG. 7C

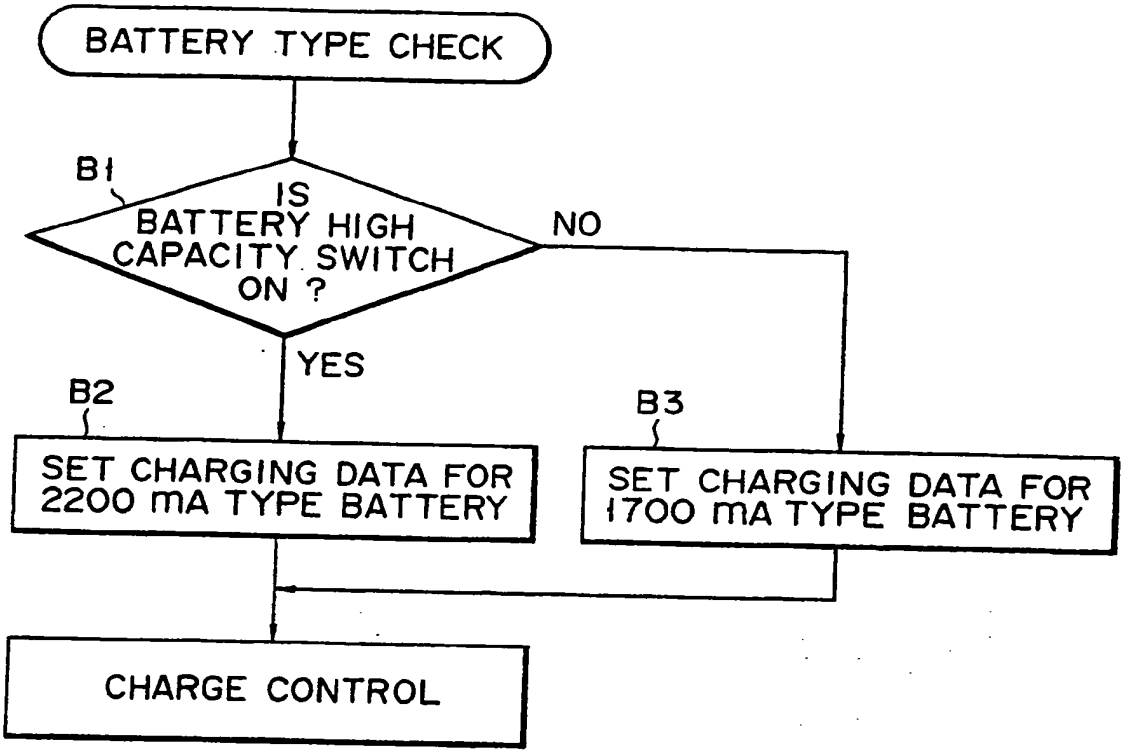

BATTERY TYPE CHECK
B1
IS BATTERY HIGH CAPACITY SWITCH ON ?
NO
YES
B2
SET CHARGING DATA FOR 2200 mA TYPE BATTERY
B3
SET CHARGING DATA FOR 1700 mA TYPE BATTERY
CHARGE CONTROL

FIG. 8

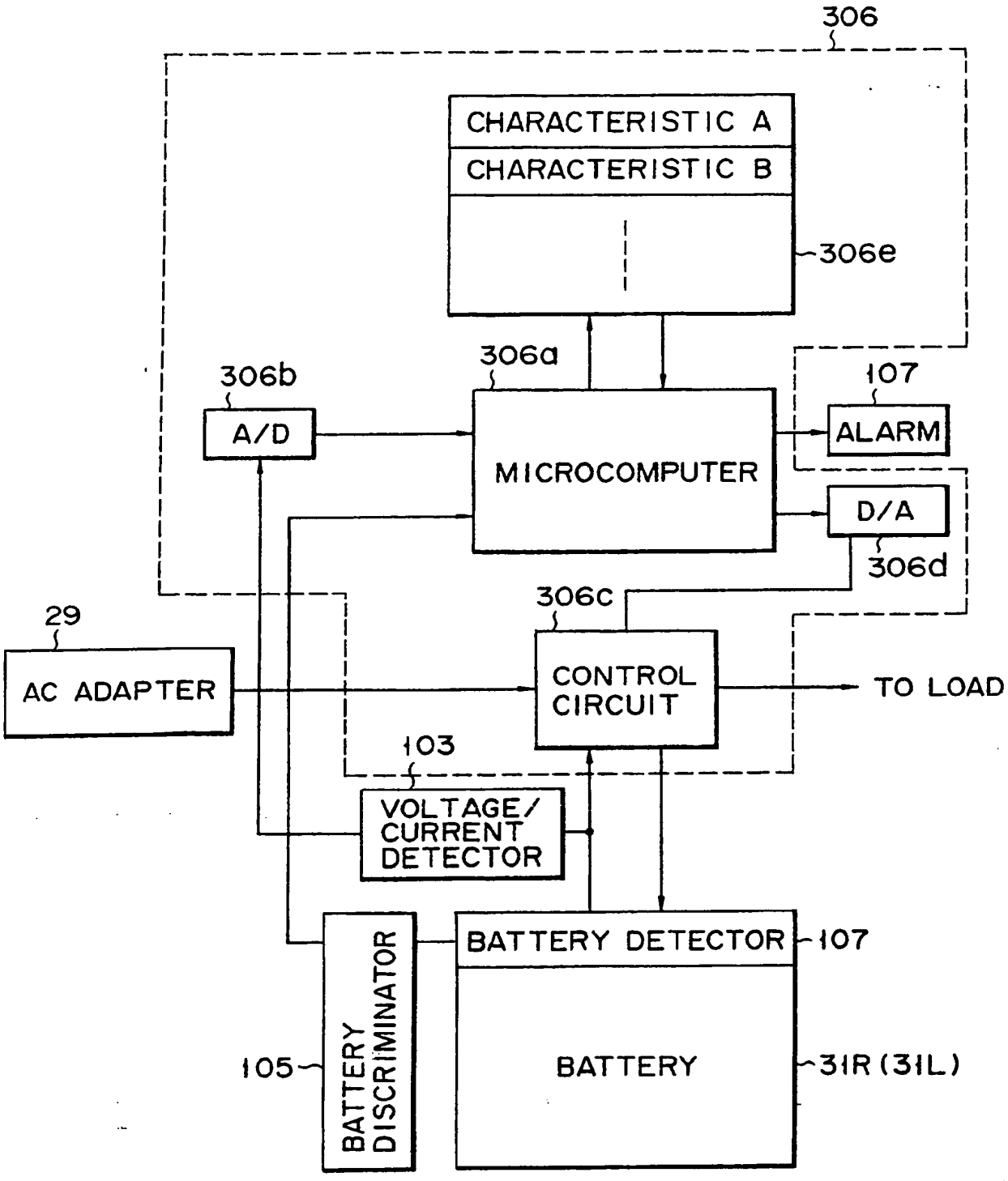

306
CHARACTERISTIC A
CHARACTERISTIC B
306e
306a
306b
A/D
MICROCOMPUTER
107
ALARM
D/A
306d
306c
29
AC ADAPTER
CONTROL CIRCUIT
TO LOAD
103
VOLTAGE/ CURRENT DETECTOR
BATTERY DETECTOR
107
105
BATTERY DISCRIMINATOR
BATTERY
31R (31L)

FIG. 9

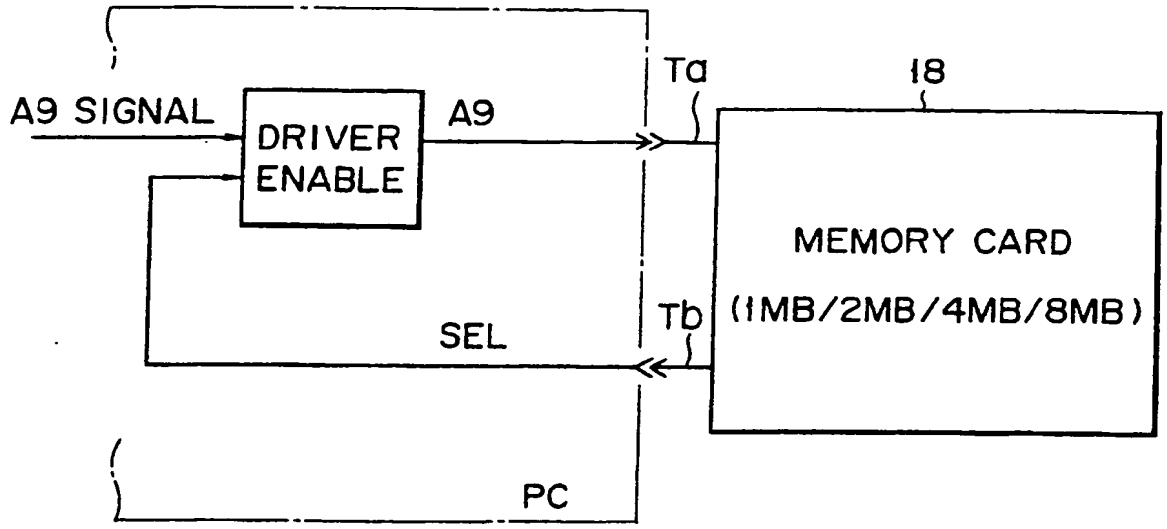


FIG. 10

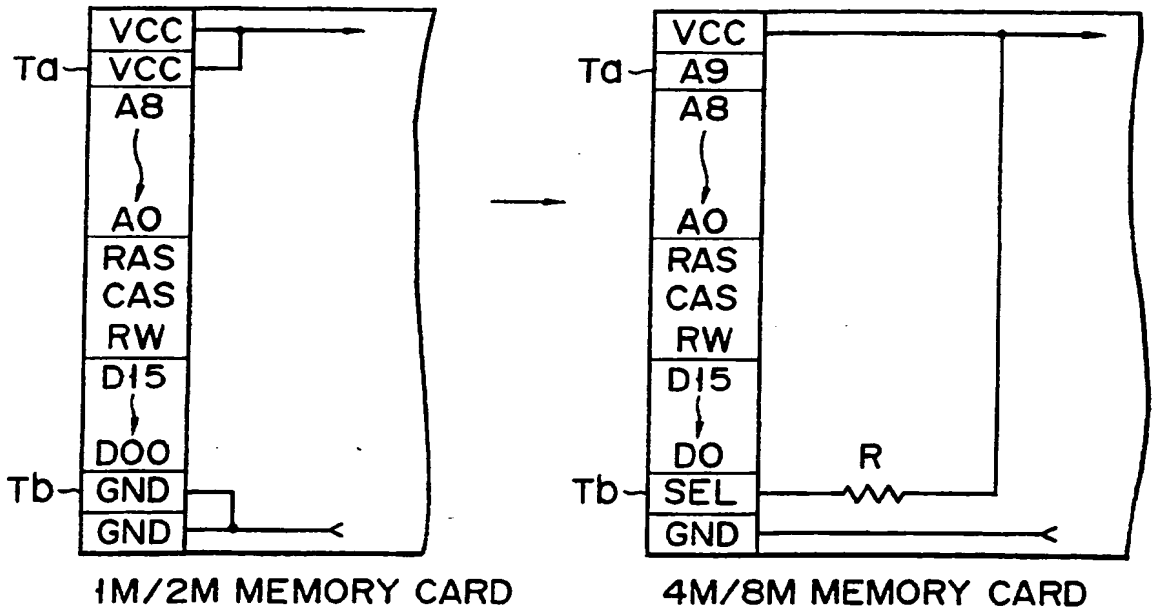


FIG. 11A

FIG. 11B

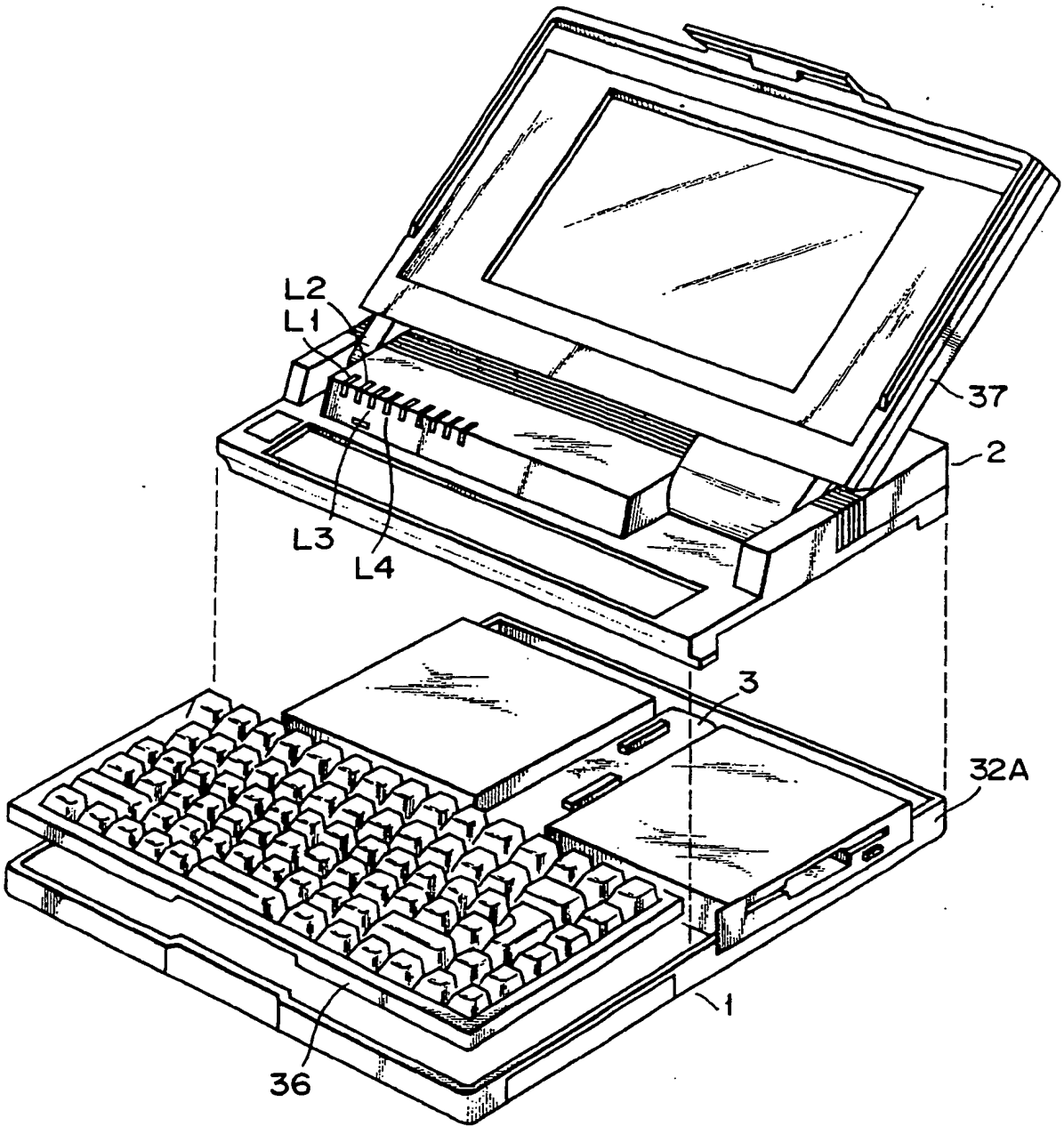


FIG. 12

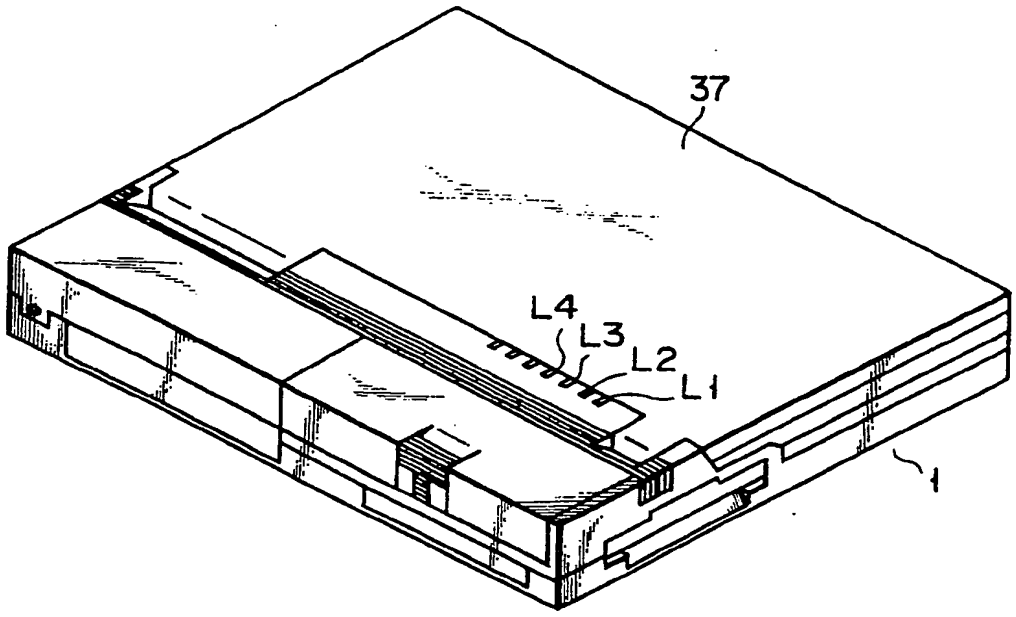


FIG. 13

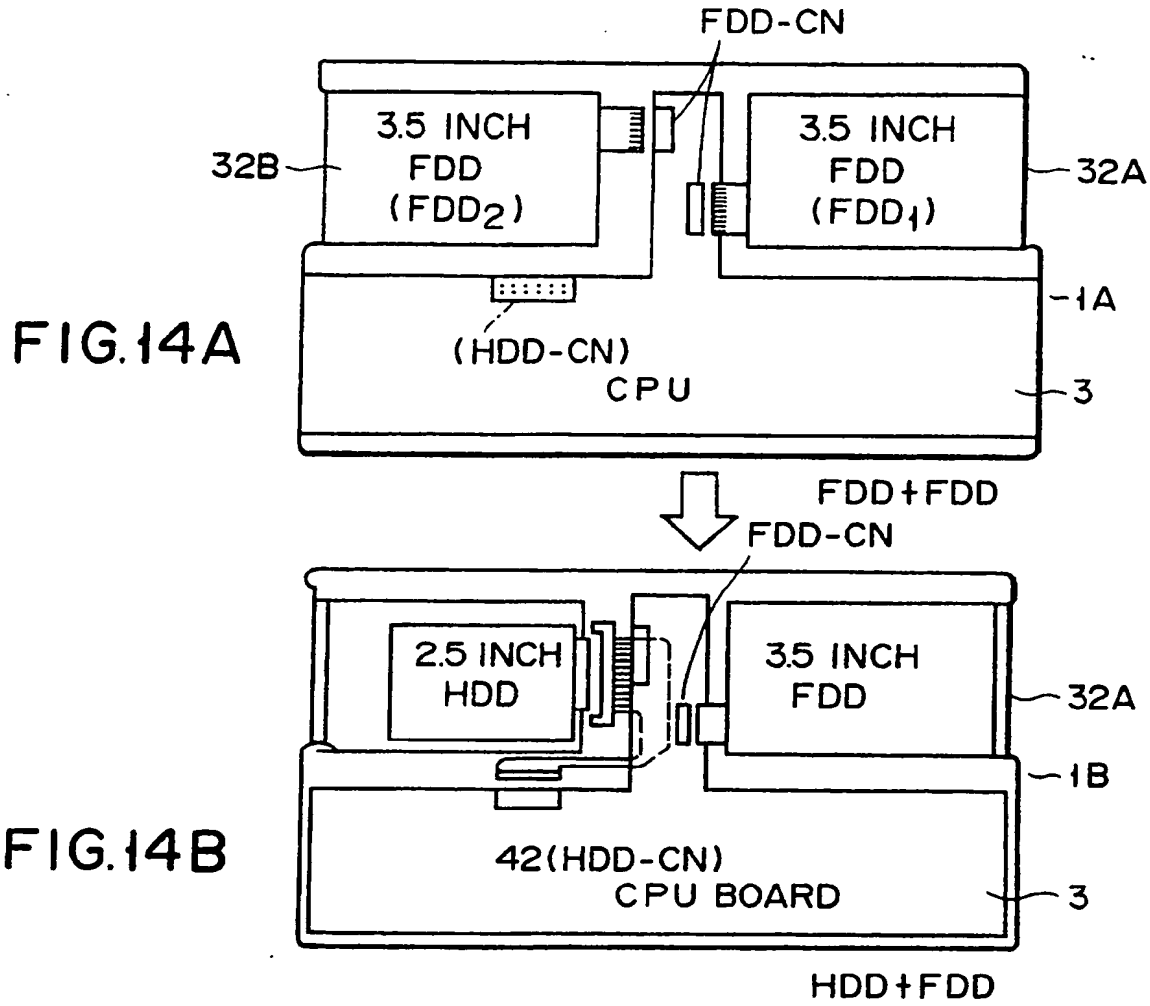


FIG.14A

FIG.14B

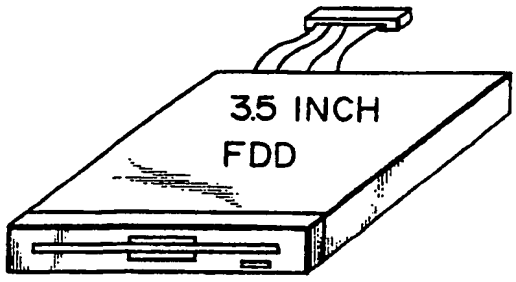


FIG.14C

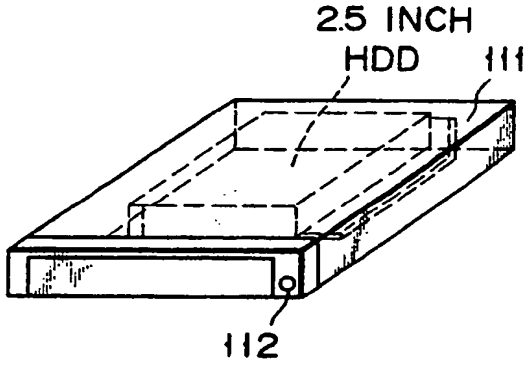
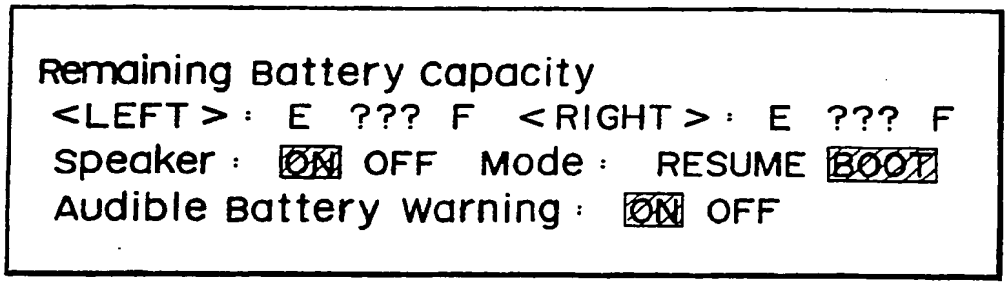


FIG.14D



E ??? F ··· BATTERY MOUNT INITIAL STATE
E N/A F ··· BATTERY UNMOUNTED STATE
E ▶▶▷▷▷ F ··· BATTERY RESIDUAL CAPACITY DISPLAY

FIG. 15

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 435 317 A3**

(12) # EUROPEAN PATENT APPLICATION

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(54) **Personal computer for performing charge and switching control of different types of battery packs.**

(57) A personal computer of this invention has a battery pack mounting section (31R) for detachably receiving battery packs having different current capacities. The personal computer also includes a switch mechanism (70, 304) for detecting whether a battery pack has a high or low capacity. Battery characteristic values consisting of charge and discharge voltage/current characteristics in units of batteries are prestored in a memory in a power control CPU (PC-CPU) (306). The PC-CPU (306) refers to the memory on the basis of capacity data from the switch mechanism and reads out the corresponding battery characteristic data. A power supply circuit (30) performs optimal charge control on the basis of this characteristic data. Two battery packs are prepared. When the PC-CPU (306) detects that the currently used battery pack is in a low-battery state, it selects the other battery pack to supply the operating power to the personal computer. At the same time the PC-CPU (306) performs optimal charge control of the battery in the low-battery state.

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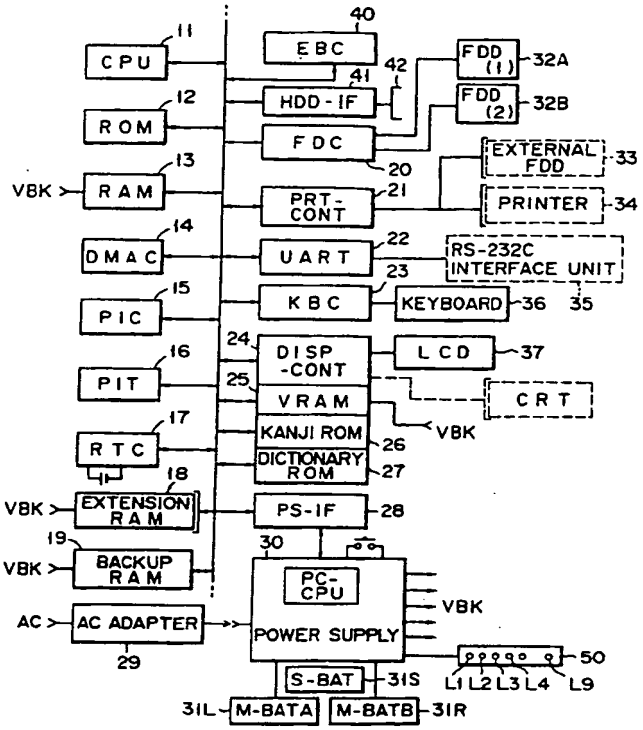
CPU
11
ROM
12
RAM
13
VBK
DMAC
14
PIC
15
PIT
16
RTC
17
EXTENSION RAM
18
VBK
BACKUP RAM
19
VBK
AC
AC ADAPTER
29
40
EBC
41
HDD-IF
42
FDC
20
PRT-CONT
21
UART
22
KBC
23
KEYBOARD
36
35
24
DISP-CONT
25
VRAM
KANJI ROM
26
DICTIONARY ROM
27
PS-IF
28
30
PC-CPU
POWER SUPPLY
VBK
S-BAT
31S
31L
M-BATA
M-BATB
31R
FDD (1)
32A
FDD (2)
32B
EXTERNAL FDD
33
PRINTER
34
RS-232C INTERFACE UNIT
LCD
37
CRT
VBK
50
L1 L2 L3 L4 L9

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 12 5673

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,Y P,A	EP-A-0 404 588 (TOSHIBA) * page 2, column 2, line 51 - page 7, column 11, line 7; figures 1-6 *	1 2-4,11	H02J7/10
P,Y P,A	EP-A-0 394 074 (MOTOROLA) * page 3, line 1 - page 7, line 46; figures 1-8 *	1 12	
P,Y	EP-A-0 392 857 (DELL) * page 3, column 3, line 35 - page 4, column 5, line 55; figures 1-6 *	1	
Y	EP-A-0 293 664 (POWER-TECH SYSTEMS) * page 3, column 3, line 10 - page 6, column 10, line 4; figures 1-6 *	12	
Y	GB-A-2 219 151 (ULO-WERK MORITZ ULLMANN GMBH) * page 5, line 8 - page 11, line 6; figures 1-10 *	12	
A	EP-A-0 340 794 (NEC) * page 2, column 2, line 19 - page 3, column 4, line 20; figures 1,2 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H02J G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 APRIL 1992	CALARASANU

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

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L : document cited for other reasons

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